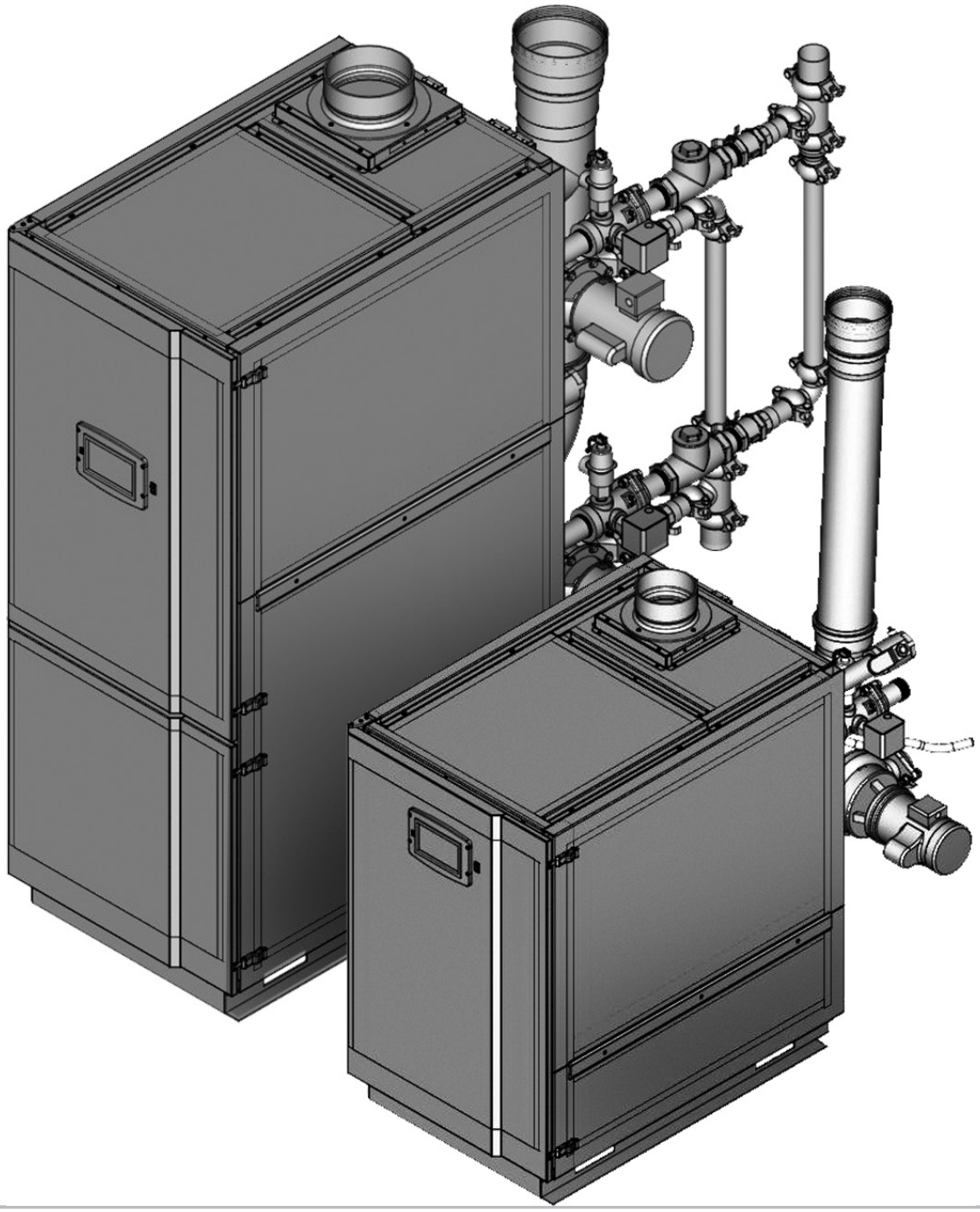
Service Handbook

COMMERCIAL BOILERS/WATER HEATERS

25589 Highway 1
McBee, SC 29101

FOR MODELS: XB/XWH
1000, 1300, 1700
2000, 2600, 3400
SERIES 100/101

INSTALLATION CONSIDERATIONS - PRE SERVICE CHECKS - BOILER/WATER HEATER CONSTRUCTION - OPERATION & SERVICE - TROUBLESHOOTING



SERVICING SHOULD ONLY BE PERFORMED BY A QUALIFIED SERVICE AGENT

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INTRODUCTION

This Service Manual covers the models and series numbers listed on the front cover only. The instructions and illustrations contained in this manual will provide you with troubleshooting procedures to verify proper operation and diagnose and repair common service problems.

QUALIFICATIONS

QUALIFIED INSTALLER OR SERVICE AGENCY

Installation and service of this boiler/water heater requires ability equivalent to that of a Qualified Agency (as defined by ANSI below) in the field involved. Installation skills such as plumbing, air supply, venting, gas supply and electrical supply are required in addition to electrical testing skills when performing service.

ANSI Z223.1 2006 Sec. 3.3.83: “Qualified Agency” - “Any individual, firm, corporation or company that either in person or through a representative is engaged in and is responsible for (a) the installation, testing or replacement of gas piping or (b) the connection, installation, testing, repair or servicing of appliances and equipment; that is experienced in such work; that is familiar with all precautions required; and that has complied with all the requirements of the authority having jurisdiction.”

If you are not qualified (as defined by ANSI above) and licensed or certified as required by the authority having jurisdiction to perform a given task do not attempt to perform any of the procedures described in this Service Manual. If you do not understand the instructions given in this manual do not attempt to perform any procedures outlined in this manual.

This product requires start-up certification by an qualified service agent that has been trained by the factory for this specific product. Call 1-800-527-1953 to locate the nearest qualified service agency and arrange a factory certified start-up.

SERVICE WARNING

If you are not qualified (as defined by ANSI above) and licensed or certified as required by the authority having jurisdiction to perform a given task do not attempt to perform any of the procedures described in this manual. If you do not understand the instructions given in this manual do not attempt to perform any procedures outlined in this manual.

SERVICE REMINDER

When performing any troubleshooting step outlined in this manual always consider the wiring and connectors between components. Perform a close visual inspection of all wiring and connectors to and from a given component before replacement. Ensure wires were stripped before being crimped in a wire connector, ensure wires are crimped tightly in their connectors, ensure connection pins in sockets and plugs are not damaged or worn, ensure plugs and sockets are mating properly and providing good contact.

Failure to perform this critical step or failing to perform this step thoroughly often results in needless down time, unnecessary parts replacement, and customer dissatisfaction.

TOOLS REQUIRED

- Instruction Manual that came with the boiler/water heater.
- All hand tools common to installation and service of commercial water heaters and boilers such as torch, pipe wrenches etc.
- TORX® T40 or 5 mm hex wrench - for setting gas mixture at gas valve.
- 3 mm or 7/64 inch hex (Allen) wrench - for setting gas mixture at gas valve.
- 6 mm allen key, Long (8-10”) T handle 1/8 inch hex (allen key) wrench for Blower removal and installation.
- Hex (Allen) wrench sizes: 1/2”, 5/32”, 1/8”, 1/4” and 5/16" or TORX® T25/T40 - for Burner, and 24V Gas Valve removal and installation.
- Two Manometers or Pressure Gauges.
  - One - U tube manometer or gauge for measuring supply gas pressure.
  - One (optionally two) digital Manometer(s) range -20.00 to +20.00" W.C., resolution 0.01" W.C. Recommend UEI model EM200, TPI model 620 or equivalent. Used to measure manifold gas pressures and to test performance of pressure switches. Optional second digital manometer can be used in place of U tube manometer for measuring supply gas pressures.
- True RMS Digital Multi Meter DMM, recommend UEI model DL289 or Fluke equivalent. Capable of measuring:
  - AC/DC Voltage.
  - Ohms.
  - DC micro amps (µA) - flame sensing current.
- AC amp meter- recommend UEI model DL289 or equivalent.
- Combustion analyzer capable of measuring:
  - CO2 (carbon dioxide).
  - CO (carbon monoxide).
  - Draft Pressure.
  - Exhaust Temperature (vent gases).

INSTALLATION CONSIDERATIONS

This section of the Service Manual covers some of the critical installation requirements that, when overlooked, often result in operational problems, down time and needless parts replacement. Costs to correct installation errors are not covered under the limited warranty. Ensure all installation requirements and instructions contained in the Instruction Manual that came with the boiler/water heater have been followed prior to performing any service procedures.

INSTRUCTION MANUAL

Have a copy of the Instruction Manual that came with the boiler/water heater on hand for the model and series number being serviced. Installation information given in this Service Manual is not a complete installation instruction. Installation information given in this manual has a limited focus as it applies to servicing the boiler/water heater. This Service Manual does not replace or supersede the Instruction Manual that came with the boiler/water heater. Always refer to the Instruction Manual for complete installation instructions. If the Instruction Manual is not on hand copies can be obtained from the manufacturer's web site or by calling the technical support phone number shown on the back cover of this manual.

CLOSED WATER SYSTEMS

Water supply systems may, because of code requirements or such conditions as high line pressure, among others, have installed devices such as pressure reducing valves, check valves, and back flow preventers. Devices such as these cause the water system to be a closed system.

THERMAL EXPANSION

As water is heated, it expands (thermal expansion). In a closed system the volume of water will grow when it is heated. As the volume of water grows there will be a corresponding increase in water pressure due to thermal expansion. This type of failure is not covered under the limited warranty. Thermal expansion can also cause intermittent Temperature-Pressure Relief Valve operation: water discharged from the valve due to excessive pressure build up. This condition is not covered under the limited warranty. The Temperature-Pressure Relief Valve is not intended for the constant relief of thermal expansion.

A properly sized thermal expansion tank must be installed on all closed systems to control the harmful effects of thermal expansion. Contact a local plumbing service agency to have a thermal expansion tank installed.

AIR REQUIREMENTS

Carefully review the requirements for combustion and ventilation air in the Instruction Manual that came with the boiler/water heater. Failure to meet these requirements when the boiler/water heater is installed or overlooking their importance when servicing the boiler/water heater often results in needless down time, unnecessary parts replacement, and customer dissatisfaction.

An inadequate supply of air for combustion and ventilation often causes operational problems. A lack of combustion and ventilation air can create a negative ambient air pressure in the installed space which can lead to improper combustion and operational problems.

CONTAMINATED AIR

Combustion air that is contaminated can greatly diminish the life span of the boiler/water heater and the components such as Igniters and Burners. Propellants of aerosol sprays, beauty shop supplies, water softener chemicals and chemicals used in dry cleaning processes that are present in the combustion, ventilation or ambient air can cause such damage.

Vapors from volatile compounds such as solvents, cleaners, chlorine based chemicals and refrigerants in addition to being highly flammable in many cases, can also react to form highly corrosive substances such as hydrochloric acid inside the combustion chamber. The results can be hazardous and cause product failure.

If the boiler/water heater is installed in beauty shops, barber shops or laundries with dry cleaning equipment, it is imperative the boiler/water heater be installed in a Direct Vent configuration so that air for combustion is derived directly from the outdoor atmosphere through a sealed intake air pipe. See the venting installation section in the Instruction Manual that came with the boiler/water heater for more information on Direct Vent installations.

VENTING

This section of the Service Manual is not a complete venting installation instruction. Refer to the Instruction Manual that came with the boiler/water heater; ensure the venting has been installed per all Instruction Manual requirements. Failing to install the factory provided vent and/or intake air terminations, exceeding the maximum equivalent vent and/or intake air piping lengths, adding too many elbows to the intake air and/or vent pipes, installing the wrong vent intake air pipe size, will cause operational problems, improper combustion, rough starting/operation and Control System lock out costs to correct installation errors are not covered under the limited warranty.

GENERAL VENTING INFORMATION

The boilers/water heaters covered in this manual are operationally equivalent to Category IV appliances and may be installed in either a Power Vent or Direct Vent configuration.

Category IV Appliance

Category IV appliances operate with a positive vent (exhaust) static pressure and with vent gas temperatures low enough to produce condensate in the vent piping.

Power Vent Configuration

Power Vent configurations derive all combustion air from the room where they are installed and discharge all flue gases to the outdoor atmosphere through a sealed vent (exhaust) pipe. Power vent configurations have one vent pipe connected to the boiler/water heater which can be terminated in a vertical or horizontal arrangement.

Direct Vent Configuration

Direct Vent configurations derive all combustion air directly from the outdoor atmosphere through a sealed intake air pipe and discharge all flue gases to the outdoor atmosphere through a sealed vent (exhaust) pipe. Direct Vent configurations have two pipes connected to the boiler/water heater, one vent pipe and one intake air pipe. Direct Vent configurations can also be terminated in a vertical or horizontal arrangement.

WATER PIPING

Ensure all water piping requirements, diagrams and piping installation instructions contained in the Instruction Manual that came with the boiler/water heater have been observed and followed. Factory installed pumps on XB boilers/XWH water heaters are sized for up to a maximum of 25 equivalent feet (7.6 m)of outlet (supply) and inlet (return) piping; 50 equivalent feet (15.2 m) total. Exceeding these limitations will lead to Control System lock outs and can permanently damage the boiler/water heater's heat exchangers. A bypass line must be installed between the outlet and inlet piping of the boiler/water heater on the "system side" of the boiler/water heater's circulation pump to prevent condensation on the copper heat exchanger.

TEMPERATURE RISE & FLOW RATE

Water flow rates through the boiler/water heater are critical. Flow rates that are too low may cause excessive lime/calcium accumulation inside the heat exchanger; while flow rates that are too high can lead to velocity erosion that can eventually cause water leaks. Boiler/water heater efficiency is also affected by flow rates. Measuring the actual water flow rate (gallons per minute) through the boiler/water heater is often impractical in the field. Because the temperature rise through the boiler/water heater is directly linked to the flow rate and is simple to measure, temperature rise is commonly used to confirm proper flow rates.

Temperature rise is calculated by subtracting the inlet water temperature from the outlet water temperature. Temperature rise is commonly referred to as the "Delta T" and expressed as ΔT. The temperature rise through the boiler/water heater should be set between 20° F and 30° F. Temperature rise (flow rate) is set by throttling a flow control valve installed in the boiler/water heater's outlet (supply) water line with the boiler/water heater firing at 100%. Never attempt to throttle the outlet valve unless the boiler/water heater is firing at 100%. Valves on the boiler/water heater's inlet (return) water line must never be throttled and left fully open at all times except when servicing the boiler/water heater. The outlet temperature, inlet temperature are shwon on the display system. Delta T (ΔT) must be below 75° F. If this is exceeded, the display will show an alert and the individual burner will lock out.

BOILER/WATER HEATER CONTROLS

The controls that are improperly installed or configured can cause serious operational and service related problems such as short cycling. This section provides information for how various controls can work together or independently to provide proper boiler/water heater and system control.

PRIMARY SYSTEM CONTROL

All installations require a “Primary System Control” that senses and reacts to water temperature inside the storage tank on domestic water applications or in the return line on primary/secondary hydronic heating systems. The Primary System Control will activate and deactivate boiler/water heater heating cycles based on its setpoint and current system water temperature. There are three suitable methods to configure a Primary System Control. One of these three methods must be used.

1. The Primary System Control can be the boiler/water heater’s control system working with the factory supplied Header Sensor, installed inside the storage tank on domestic water applications or in the return line on primary/secondary hydronic heating systems for XB.
2. Alternatively, on XWH water heater the Burner Control system can be used as a Primary System Control. It will also provide water heater status and error reporting. Multiple water heaters can be joined together to heat a system instead of a single, larger burner or boiler/water heater. Using boilers/water heaters in parallel is more efficient, costs less, reduces emissions, improves load control, and is more flexible than the traditional large boiler/water heater.
3. MB2 and COM2 ports can be used for Building Management Systems.

FIELD WIRING

120 VAC Power Supply Wiring

A dedicated, single phase, 30/60 amp circuit breaker with a grounded neutral should be provided to supply power to the boiler/water heater(s). Use #10 AWG wire for the 120 VAC power supply to the boiler/water heater. All 120 VAC power supply connections must be made as shown in Figure 1. These connections should be made at the rear of the boiler/water heater where a wiring junction box is provided. Field installed power supply wiring to the boiler/water heater should be installed in conduit. This conduit and wiring should be separate from any other conduit/wiring to guard against EMI (electromagnetic interference).

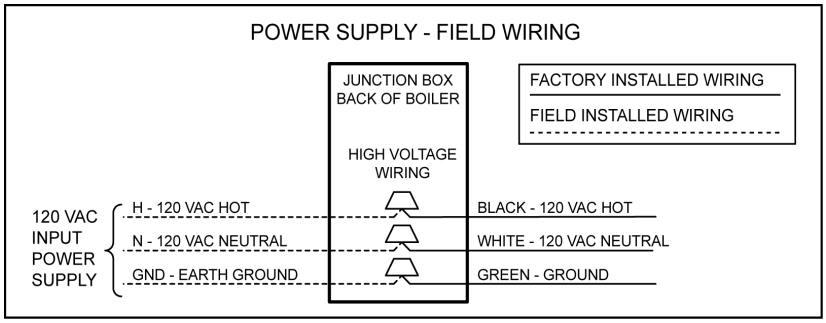


FIGURE 1. FIELD WIRING

Power Supply Check

To reduce the possibility of electrical interference with the control system, the power supply voltage, polarity and ground must be checked. Using an AC volt meter check the 120 VAC power supply wiring from the breaker prior to making power supply connections at the boiler/water heater. Confirm the power supply voltage & polarity are correct and that an adequate ground connection is present by performing the three voltage tests below. See Figure 1.

Confirm RMS voltage between:

- H and GND = 108 VAC minimum, 132 VAC maximum.
- N and H = 108 VAC minimum, 132 VAC maximum.
- N and GND = < 1 VAC maximum.

INSTALLATION CHECKLIST

The list below represents some of the most critical installation requirements that, when overlooked, often result in operational problems, down time and needless parts replacement. Before performing any troubleshooting procedures use the list below to check for installation errors. Costs to correct installation errors are not covered under the limited warranty. Ensure all installation requirements and instructions contained in the Instruction Manual that came with the boiler/water heater have been observed and followed.

1. The vent (exhaust) pipe must not be combined or connected to any other appliance's vent system or chimney.
2. The intake air pipe must not be combined or connected to any other appliance's intake air piping.
3. The boiler/water heater(s) covered in this manual are condensing appliances. Condensate will form in the vent pipe during normal operation, condensate can also form in the intake air piping in certain circumstances. Ensure the intake air and/or vent piping is not installed in a manner that will allow water to be trapped in the piping. This will lead to blocked exhaust and/or blocked air intake fault conditions and Control System lock outs.
4. Ensure the intake air and/or vent piping is the correct size for the installed length. See the venting requirements section in the Instruction Manual that came with the boiler/water heater. Using smaller pipe than is required will lead to blocked exhaust and/or blocked air intake fault conditions and Control System lock outs.
5. Ensure the intake air and/or vent piping are within the maximum equivalent lengths required in the Instruction Manual that came with the boiler/water heater. Exceeding the maximum length or number of elbows allowed will also lead to blocked exhaust and/or blocked air intake fault conditions and Control System lock outs.
6. Ensure there is a water trap formed in the condensate drain tube/line connected to the exhaust elbow on the boiler/water heater and that the condensate drain is flowing freely. Condensate drain blockage will cause the heat exchanger to fill with water and lead to blocked exhaust fault conditions and Control System lock outs.
7. Ensure the vent and intake air terminations have adequate clearances from each other and the terminations of other appliances. Failure to maintain adequate clearances can cause the recirculation of flue gases between the vent and intake air piping. Recirculation of flue gases will cause poor combustion, sooting, ignition failure, rough starts, rough operation, premature failure of the heat exchanger and icing of the combustion air intake during severe cold weather.
8. Direct vent terminations being installed in dead air spaces such as alleys, atriums, and inside corners can also cause the recirculation of flue gases between the vent and intake air piping. To prevent the recirculation of flue gases, maintain as much distance as possible between the intake air and vent terminations.
9. Ensure the screens in the factory supplied terminations are securely installed to prevent blockage in the intake air and/or vent piping.
10. On Direct Vent installations ensure the screen at the intake air connection on the water heater was removed before the intake air piping was connected.
11. Ensure the power supply connections to the water heater are polarity correct. Use the Digital Multi Meter to verify correct polarity and ground at an outlet the water heater is plugged into. Reversed polarity (neutral and hot wires reversed) will cause the AC Reversed fault condition and Control System lock out.
12. Ensure the boiler/water heater and the burner are properly grounded. The Control System requires an adequate earth ground for flame sensing (verification). Inadequate grounding to the water heater and/or the burner will cause the Ignition Failure fault condition and Control System lock out.

FEATURES AND COMPONENTS

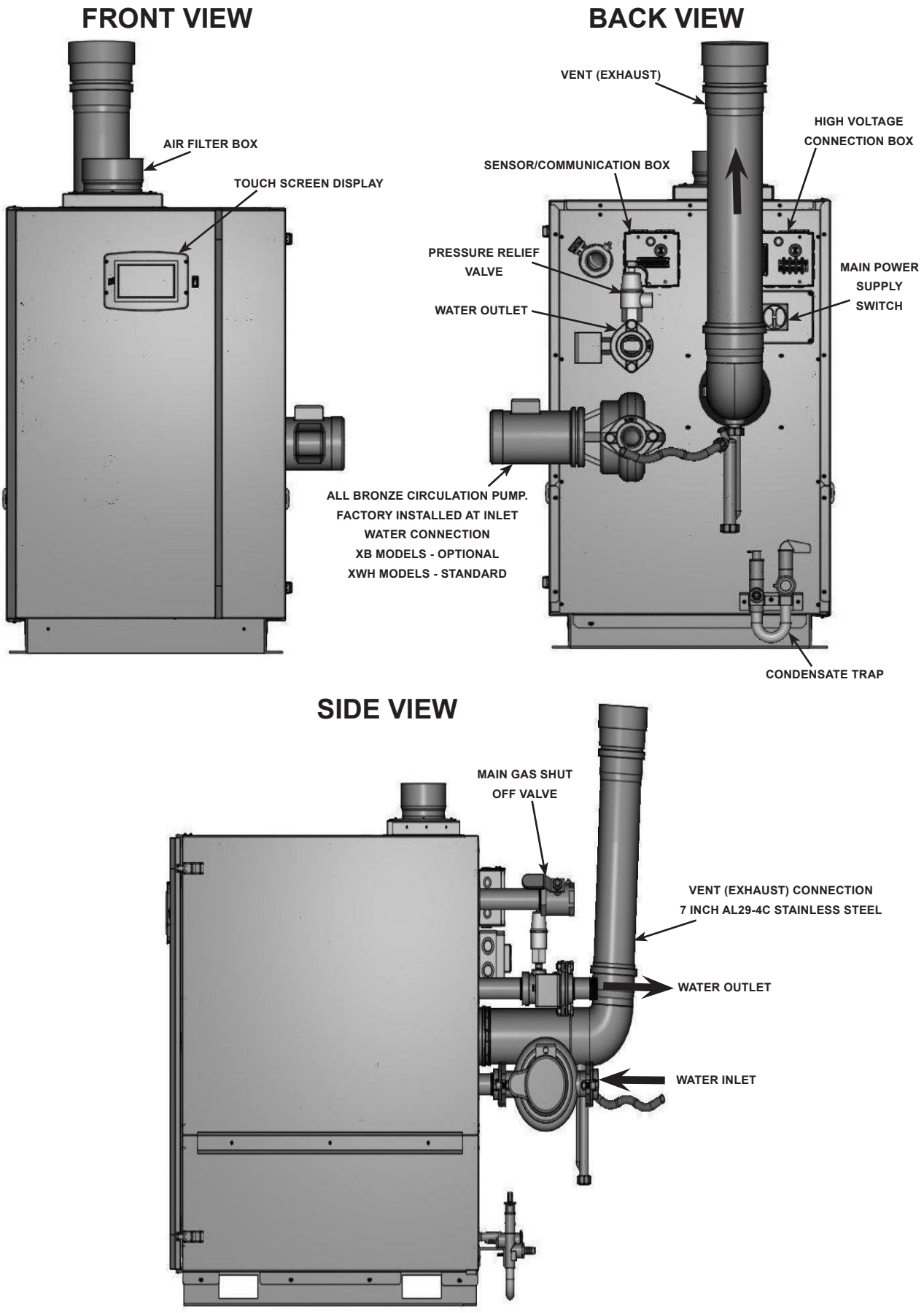


FIGURE 2. SINGLE HEAT EXCHANGER BOILER/WATER HEATER - 1000/1300/1700

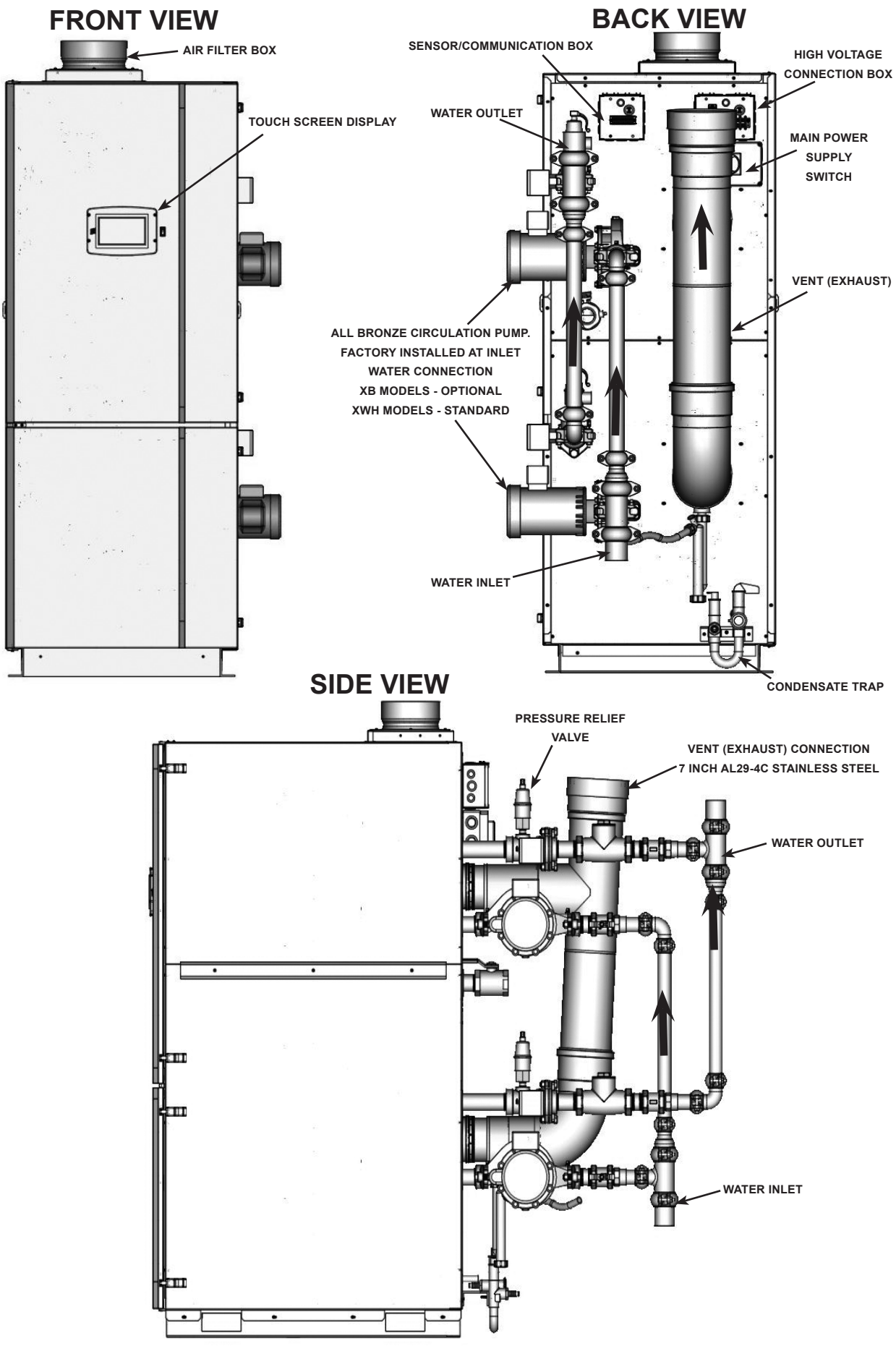


FIGURE 3. DOUBLE HEAT EXCHANGER BOILER/WATER HEATER - 2000/2600/3400

OPERATION AND SERVICE

MODULATING FIRE OPERATION

XB boilers & XWH water heaters are modulating systems. The control system modulates the firing rate of the burner to match system load by controlling the speed of the combustion blower.

They do not have a gas orifice. The combustion blower "pulls" fuel gas from the outlet of the 24 VAC gas valve (when energized) into a venturi that is connected to the inlet of the Combustion Blower. The firing rate is directly proportional to the speed of the combustion blower motor. As the blower speed increases, the pressure inside the venturi falls creating a stronger vacuum which pulls more fuel gas into the blower/burner assembly which increases the firing rate.

The control system controls the speed of the combustion blower in response to system temperature. As the system temperature falls blower speed is increased to provide more heating capacity. The control system sends digital speed instructions to the electronic speed control which is part of the combustion blower assembly.

COMBUSTION BLOWER

The combustion blower is an assembly that includes the blower motor, housing and an integral electronic speed control. The power junction box sends 120 VAC and an earth ground from its J3 socket to the 120 VAC 3 pin socket on the combustion blower assembly to power the electronic speed control. The control board sends a PWM (Pulse Width Modulation) signal, an instruction to start, stop and control the blower motor speed from the J2 socket to the 5 pin wiring socket on the combustion blower assembly. Four wires from the J2 socket on the control board carry this instruction to the 5 pin wiring socket on the combustion blower assembly, see Figure 4 below.

TABLE 1. COMBUSTION BLOWERS

XB/XWH MODELS	BLOWER PART NUMBERS
1000/2000	EBM RG-175
1300/1700/2600/3400	EBM G1G170-AB05-20

Service Note:

The 5 pin PWM signal plug must remain plugged in to the 5 pin socket on the blower assembly at all times. Disconnecting this plug will cause the combustion blower to run at maximum speed continuously. This may cause rough starts, rough operation and control system lock out. If the electronic speed control is functioning properly combustion blower speed should noticeably reduce during the operating state. If blower speed reduction does not occur during the operating state ensure the 5 pin plug from the control board is securely plugged into the matching 5 pin socket on the blower assembly and that the J2 plug is securely plugged into the J2 socket on the control board. Perform a close visual inspection of the pins inside the plugs and sockets at the combustion blower and the control board, replace any worn or damaged wiring harnesses as necessary.

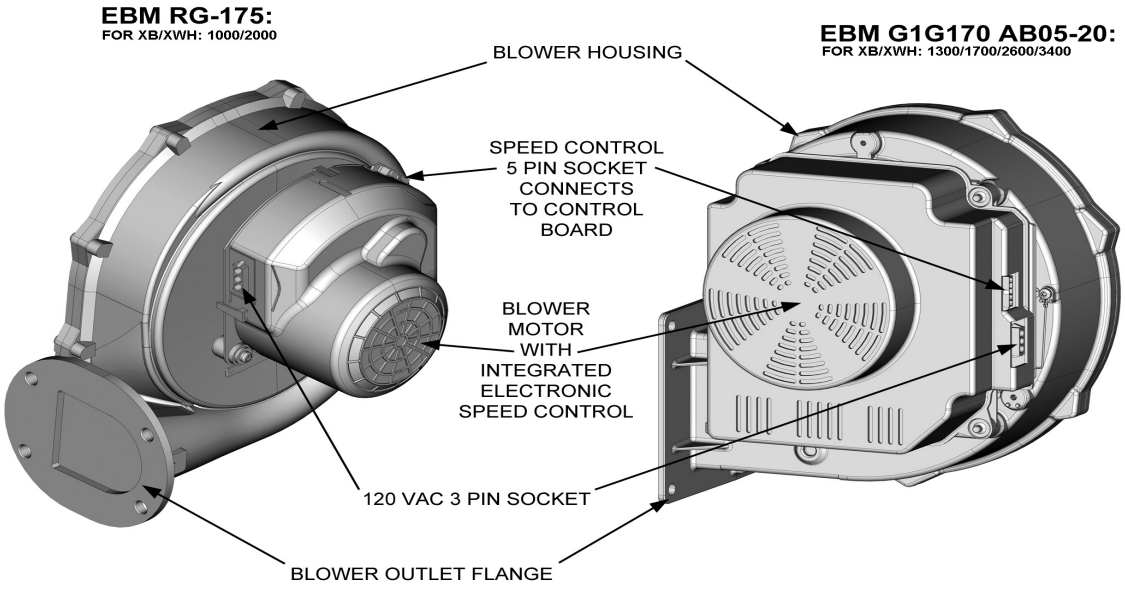


FIGURE 4. COMBUSTION BLOWER ASSEMBLY

HEAT EXCHANGER ASSEMBLY

The heat exchanger transfers heat from the hot flue gases to the heating system's water. Combustion products including flue gas condensate, which are formed in the heat exchanger are evacuated. The heat exchanger includes the following interfaces:

- 2x Burner doors
- Flue gas outlet connection
- Water inlet and outlet connection
- Condensate connection
- Bushes for sensor

Heat from the hot flue gases is transferred to the heating water through a spiral tube made from stainless steel. The heat exchanger is equipped with an evacuation for the combustion products at the back side. The burner doors should integrate a double tightness: a gasket insuring a thermal protection and a gasket tight to the condensates and flue gas. The burner door should be in contact with the front panel of the heat exchanger in order to limit the risk of leakage from combustion products in case the gaskets are incorrectly reinstalled. Bolts on the front of the boiler/water heater can withstand forces resulting from the weight of the front panel and assembled parts (burner door, fan, gas valve, venturi, air-gas sleeve). Maximum nuts torque for assembling the burner door is 3.7 ft.lb.

Minimum working pressure rated capacity is 14.5 PSI (100 kPa) and the minimum water volume is 1.1 GPM (4.2 LPM) per tube. Under these conditions the maximum temperature difference between the outgoing and returning water is 80°F (26.7°C). With a Maximum Allowable Working Pressure of 160 PSI (1103.2 kPa), the exchanger's hot water circuit system does not tolerate long-lasting leaks or deformations. Minimum water pressure for a closed-loop system must not be lower than 14.5 PSI (100 kPa). Normal Heating circuit water temperature is 41°F – 203°F (5°C - 85°C).

The ambient temperature around the product must not exceed 140°F (60°C) and the ambient relative humidity (RH) can vary from 0% to a maximum of 90%. In the extreme case of a safety component malfunctioning and causing the system to overheat to a temperature higher than 203°F (85°C) (closed system), the water temperature shall not exceed 210°F (99°C) referring to the ASME Code Section IV for austenitic stainless steel materials. The maximum surface temperatures for the casing, back panel and front panel must not exceed 302°F (150°C).

The Trio ASME "H" Heat Exchangers are equipped with 2 water male connections with NPT threading, according to the ANSI/ASME B1.20.1 standard, which are dimensioned according to the capacity of the heat exchanger. A female NPT 1/8" threaded connection type, according to the ANSI/ASME B1.20.1 standard, is available on the water flow and on the water return header of each stage in order to receive some NTC sensors able to control the water flow and return temperature and/or to use its as a limiter and safety thermostat.

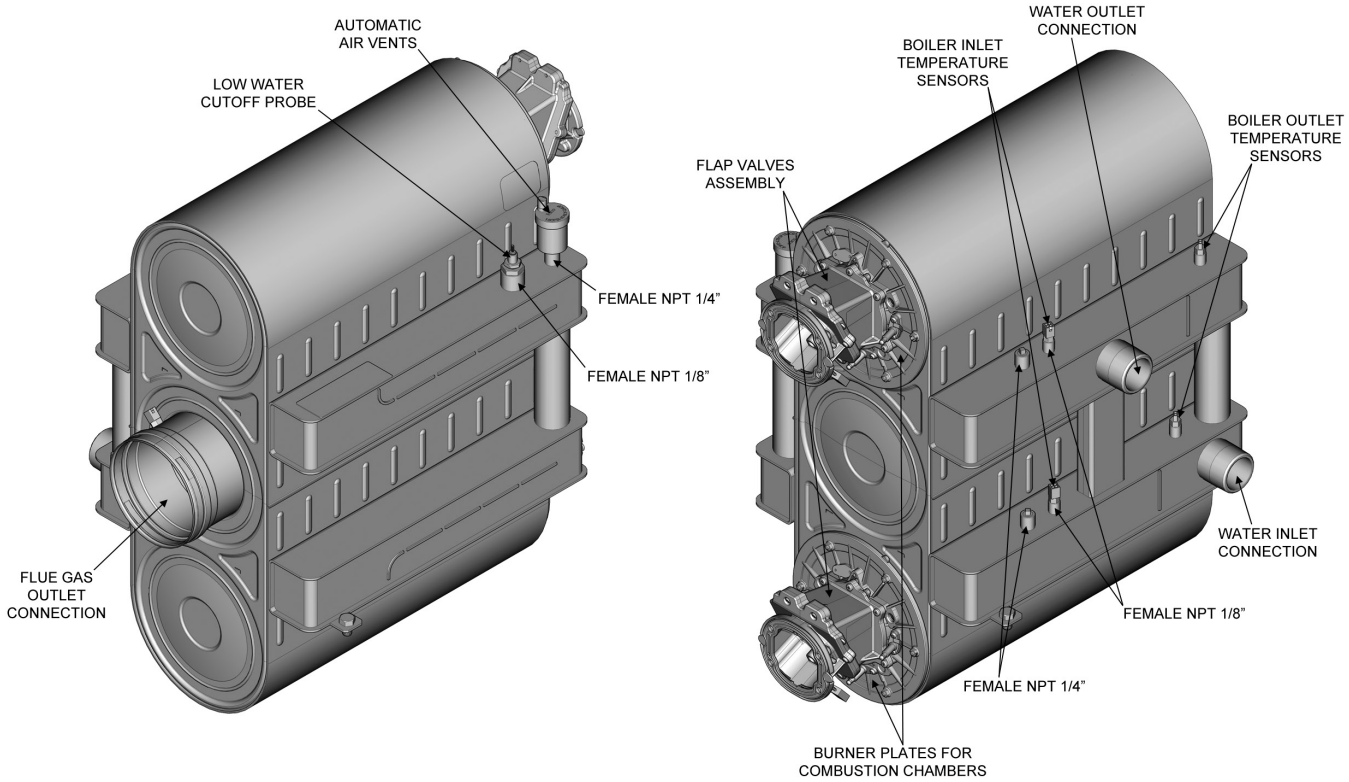


FIGURE 5. HEAT EXCHANGER ASSEMBLY

Water Connection

Heat Exchangers are equipped with 2 water male connections with NPT threading, according to the ANSI/ASME B1.20.1 standard, which are sized according to the capacity of the heat exchanger.

Flue Gas Outlet Connection

The heat exchanger is equipped with an evacuation for the combustion products at the back side. Flue gas outlets are sized according to the capacity of the heat exchanger.

A. O. Smith recommends the recovery and the evacuation of the flows coming from the chimney, mainly if there's a risk of remains in the chimney's channel, in order to avoid that they return in the heat exchanger.

Burner Door/Plates Connection

A. O. Smith recommends that the burner doors should integrate a double tightness, a gasket insuring a thermal protection and a gasket tight to the condensates and flue gas.

A. O. Smith recommends as well that the burner door should be itself in contact with the front panel of the heat exchanger in order to limit the risk of leakage from combustion products in case of lack of remounting the gaskets.

Bolts on the front of the boiler/water heater can withstand forces resulting from the weight of the front panel and assembled parts (burner door, fan, gas valve, venturi, air-gas sleeve). Maximum nuts torque for assembling the burner door is 3.7 ft.lb.

Operating Conditions - Installation factors

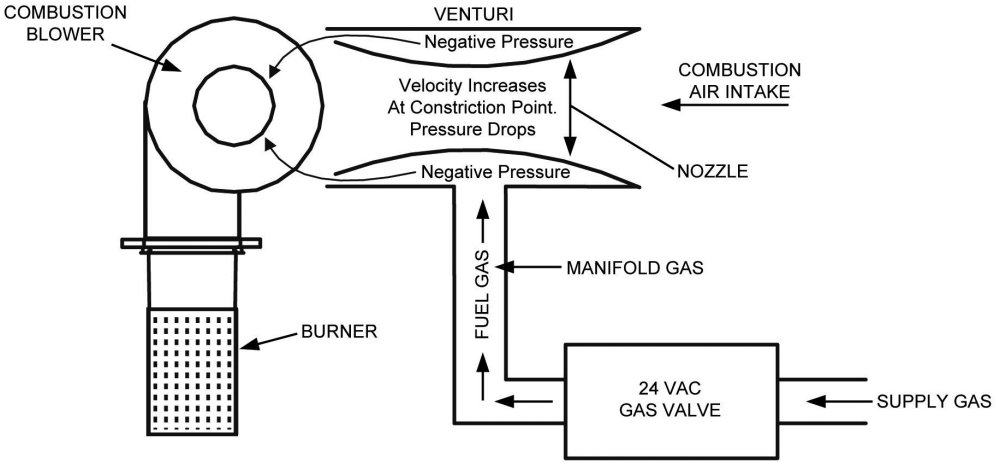
Heating units will be subject to the effects of corrosion from the moment they are filled with water. It is however essential that the following installation factors are taken into account in order not to worsen the phenomenon of corrosion.

- Combustion air must not contain chlorine, ammonia, or alkali agents. Installation of the product near a swimming pool, a washing machine, or a laundry do expose combustion air to these contents.
- The heat exchanger must be used filled with water within the temperature and pressure limits specified in its technical specification booklet.
- The water's pH must fall within the following limits: 7.5<pH<9.5 and if the system contains aluminium parts, it must be less than 8.5. This pH value is achievable after steady state conditions after filling the mains network water (pH around 7) inside the installation and the air bleeding operation has been done (death water condition).
- Water hardness must fall within the following limits:
  - 5°F<TH<15°F
  - 3 Grains/US gallon<TH<9 Grains/US gallon
- To avoid to the maximum presence of oxygen in the system, it is advised to prevent as much as possible air intake and water leakage during installation. Usual spots where air is most likely to seep in are: suction gasket, pump, air valve working as venting pipe, O-rings gaskets in stuffing box. Using an automatic water refill system reduces some risk (as any fresh water is bringing fresh oxygen in the system), like installing a water meter so that it is possible to evaluate the water volume in order to eliminate any water leakage as early as possible.
- A minimum water pressure, adapted to each exchanger type, is requested in order to allow good performances.
- A. O. Smith recommends to the customers to carry out the drain of the heat exchanger after test or use in order to avoid consequences on the product in the event of freezing ; the expansion of the water in case of freezing could cause degradations or leakages.

VENTURI AND GAS TRAIN ASSEMBLY

The gas train includes a venturi connected to the inlet of the combustion blower. The outlet of the 24 VAC gas valve is also connected to the venturi by a manifold gas line. There is a shutoff valve installed in the manifold gas line for start up and service procedures. The venturi contains a convergent/divergent nozzle (cone shaped restrictor) that constricts the air passage to the blower. As air enters the constriction point its velocity increases. A pressure drop occurs at this point and creates a negative (vacuum) pressure in the cavity between the nozzle and the venturi housing. This negative pressure "pulls" gas from the outlet of the 24 VAC gas valve into the blower where it is mixed with combustion air and then supplied to the burner, see Figure 6.

As the combustion blower speed is increased the velocity of air flowing through the venturi is also increased. This increases the vacuum created by the venturi and more fuel gas is pulled from the 24 VAC gas valve and supplied to the burner. This increases the firing rate (input Btu/hr) of the boiler/water heater. As the blower speed is decreased less fuel gas is supplied to the burner and the firing rate is reduced.



VENTURI OPERATION

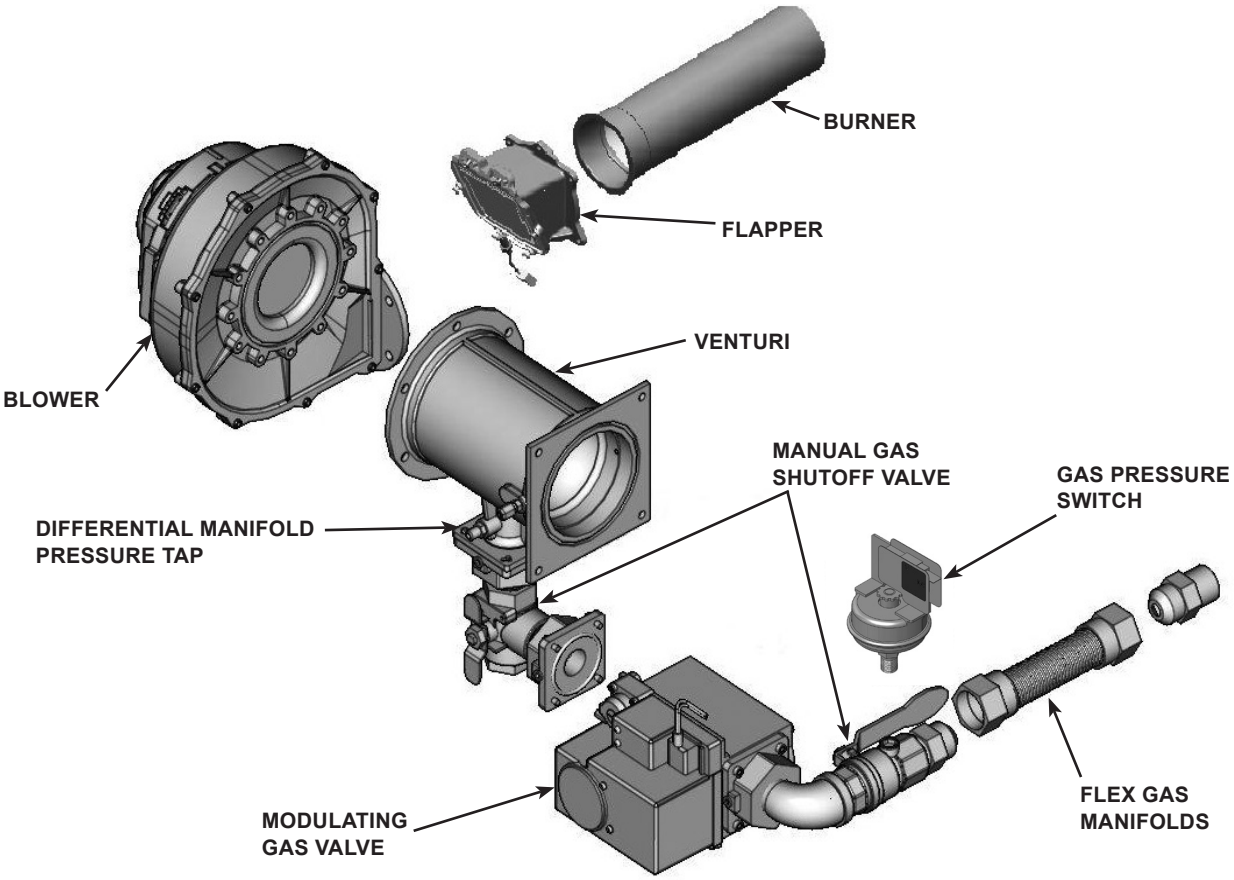


FIGURE 6. VENTURI AND GAS TRAIN ASSEMBLY

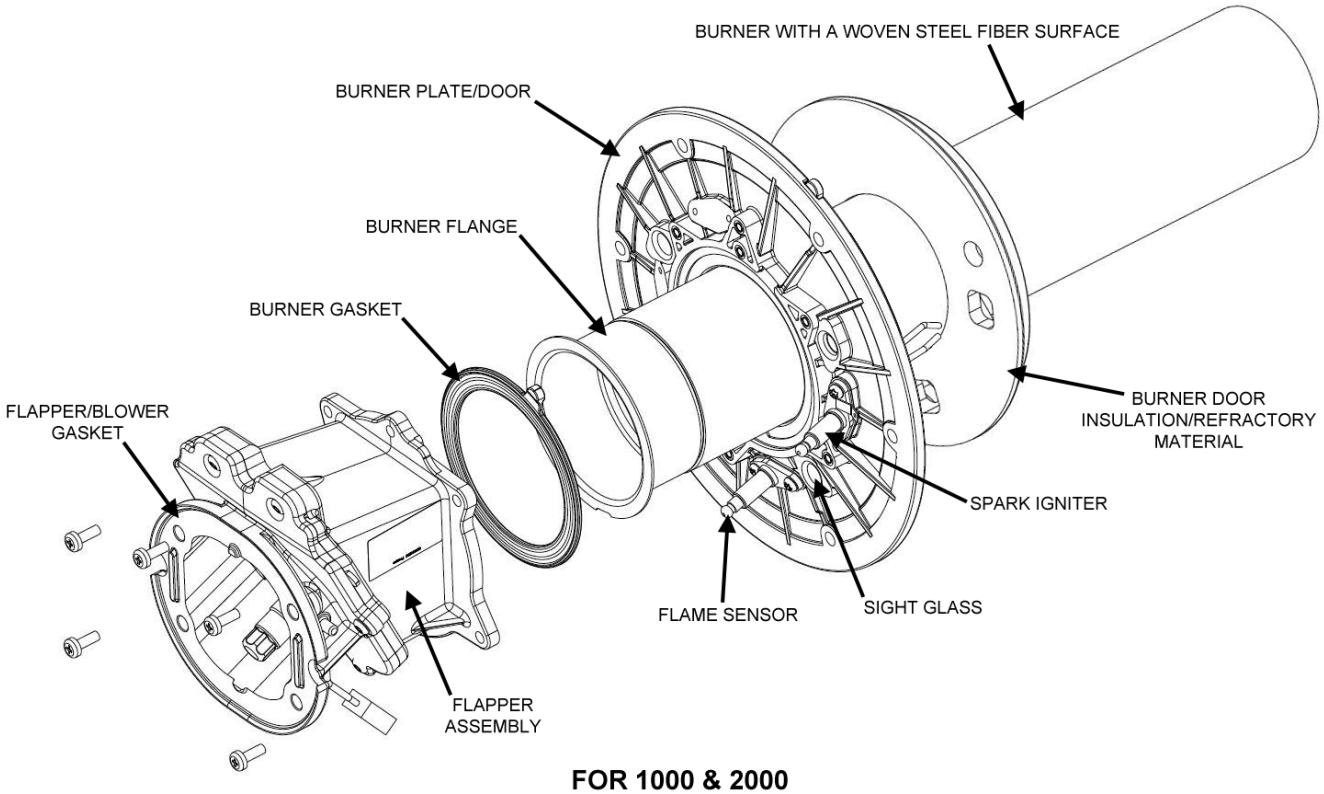
BURNER ASSEMBLY

The burner is a stainless steel radial fire burner with a woven steel fiber surface. It is installed in the center of the horizontal heat exchanger. The burner is mounted inside the recess of the heat exchanger.

The spark igniter on the boiler/water heater is a 120VAC igniter. The igniter receives power from the J5 socket on the Control Board. The 110V from the board is then passed to an ignition transformer. From the ignition transformer the spark ignitier is energized.

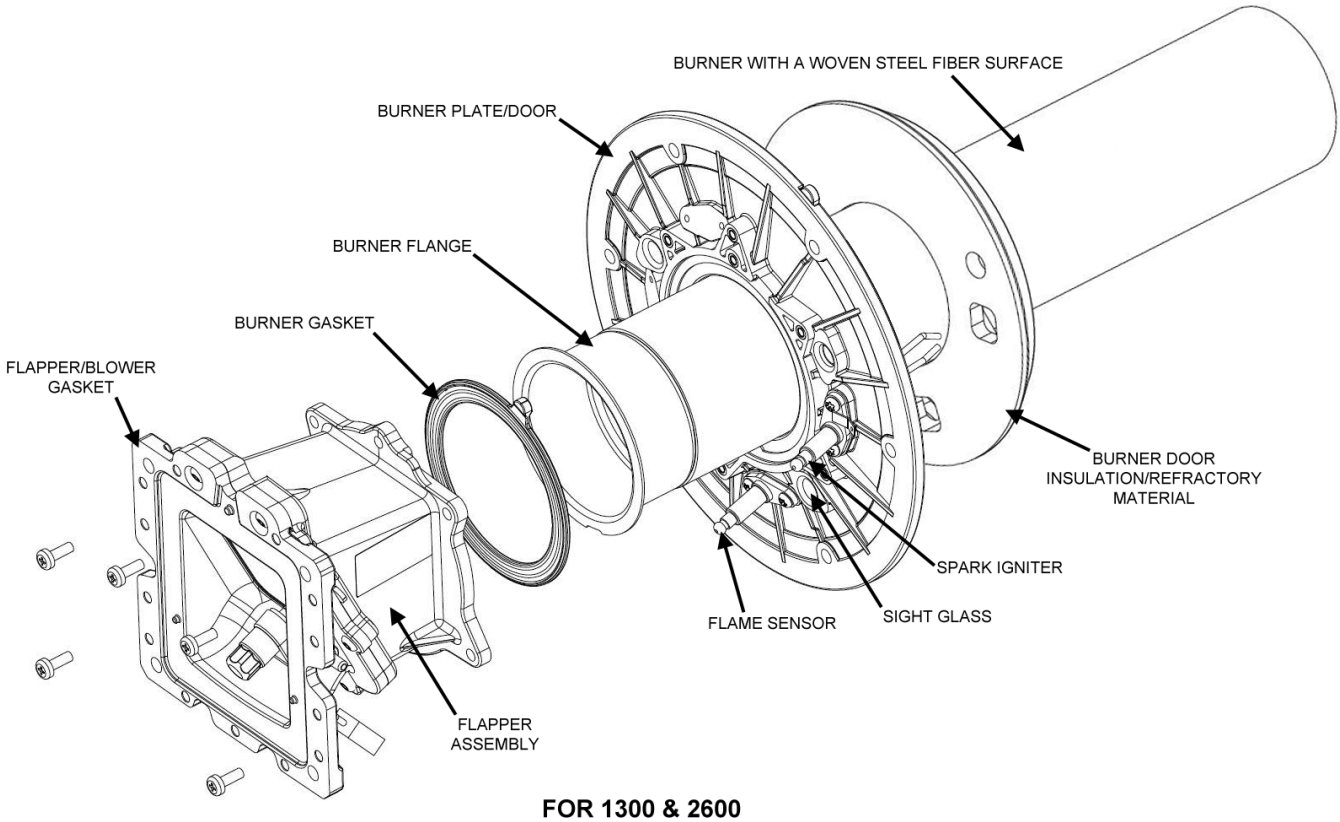
A Low/High Gas Pressure Switch is installed on the gas manifold. The Low Pressure Gas Switch is a normally open switch that closes on a rise in pressure. Switch contacts closes in between +4" W.C.(minimum) - +14" W.C.(maximum) on natural gas models and +4" W.C.(minimum) - +14" W.C.(maximum) on propane gas models. The High Gas Pressure Switch is normally closed and is used to detect excessive gas pressure.

Boilers/water heaters have only one flame sensor per individual burner. The flame sensor is mounted close to the burner to sense the flame firing rates.



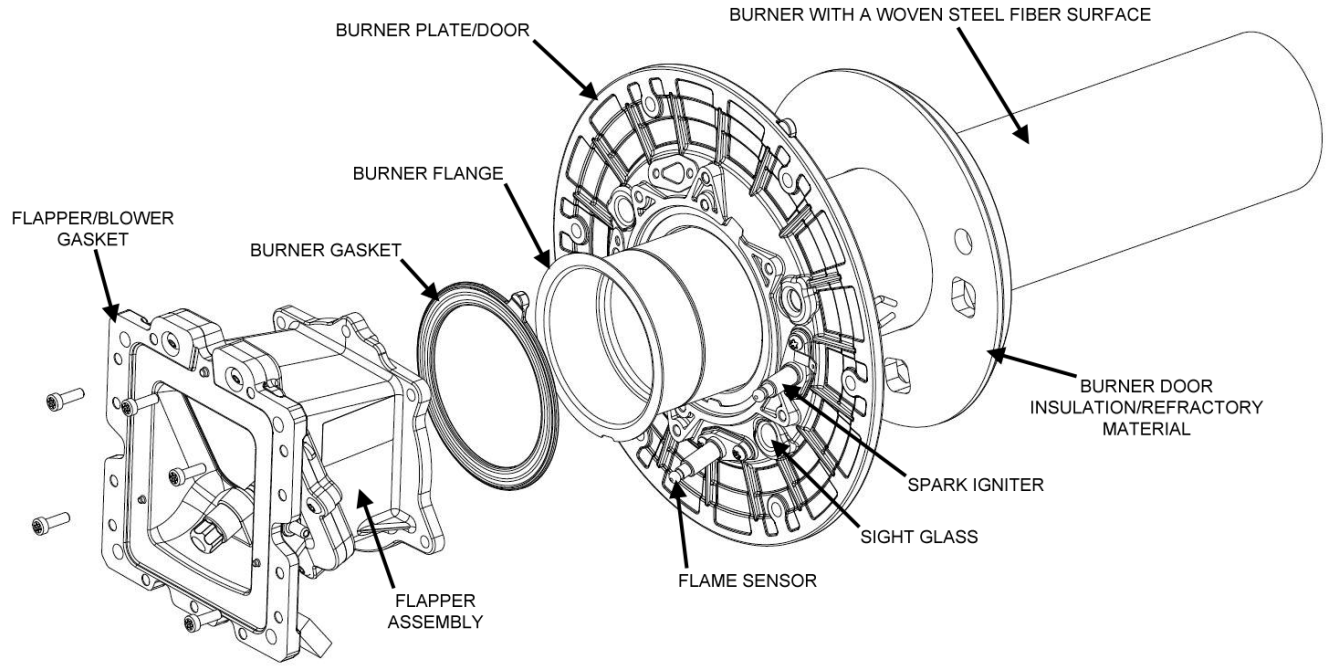
FOR 1000 & 2000

FIGURE 7. BURNER ASSEMBLY (1000/2000)



FOR 1300 & 2600

FIGURE 8. BURNER ASSEMBLY (1300/2600)



FOR 1700 & 3400

FIGURE 9. BURNER ASSEMBLY (1700/3400)

FLAME SENSOR

Ignition of the burner is controlled electronically. The principle of operation for electronic ignition relies on flame sensing voltage to prove the fuel gas flowing to the burner has been ignited and is burning safely.

Flame sensing requires correct power supply polarity and an adequate earth ground to the boiler/water heater's burner. See Figure 7 on Page 15, Figure 8 and Figure 9 on Page 16 for the Burner Assembly.

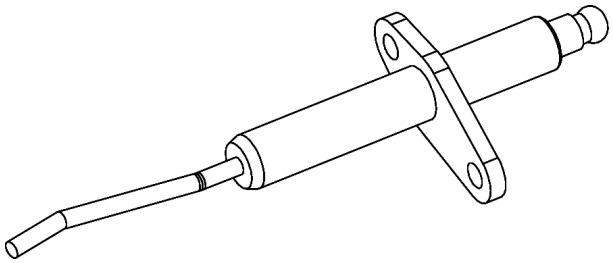


FIGURE 10. FLAME SENSOR

Flame Sensing Operation

- The Flame Sensor is a metal (conductor) rod mounted in a ceramic insulator.
- The Control System applies an AC voltage to the Flame Sensor through a single wire.
- The burner flame will conduct a small amount of electrical current.
- The Burner must be grounded for current to flow from the Flame Sensor to the Burner.
- During ignition the burner flame must make complete and continuous contact with the Flame Sensor.
- As the AC voltage flows from the Flame Sensor through the burner flame to the (grounded) Burner, the AC voltage is "rectified" and becomes a DC voltage.
- Flame sensing voltage can be measured with a Digital Multi Meter. See Tools Required on Page 4.

Flame Signal Processing

The flame signal processing will monitor the flame sensor. The flame signal voltage at the test jacks or on the bar graph on the display is the measured voltage in the range from 0V to 30V. The display could show stronger numerical data.

The incoming flame signals are filtered to eliminate transient and spurious events. The flame failure response time (FFRT) is 4 seconds. Flame sensitivity is set by the Flame Threshold parameter, which will provide the ON/OFF threshold specified in volts.

Service Notes:

- Ensure you have identified the correct Flame Sensor wire before performing a flame sensing test to prevent damage to the test meter.
- The most common cause of ignition failure is a corroded Flame Sensor. Rust/corrosion will accumulate on the Flame Sensor over time. The Flame Sensor should be inspected and cleaned anytime the measured flame sensing voltaget is at a minimum of 1 volt or the Burner has been removed. Clean the Flame Sensor with ultra fine steel wool. DO NOT use a coarse abrasive material such as sand paper for cleaning. Inspect the ceramic insulator on the Flame Sensor for cracks, replace the Flame Sensor if it is damaged. The Combustion Blower and Burner must be removed to access the Flame Sensor.
- An open flame sensing circuit caused by disconnected or loose connectors can also cause ignition failure. Check all wiring connections between the Flame Sensor and the J1 connector on Control Board.
- The burner not being grounded will cause ignition failure. Ensure the boiler/water heater and the burner are properly grounded.

SPARK IGNITER

The Spark Igniter is made of a ceramic composite material, see Figure 11 below. The Control System powers the Spark Igniter (120 VAC) from the pin 6, J5 connector on the Control Board to the External Spark Transformer.

Spark Igniters are service parts, over time Spark Igniters will wear out and must be replaced as they will no longer generate enough spark to cause ignition.

Before troubleshooting the Spark Igniter it is recommended to check the reasons for ignition failure such as no gas, air in the gas line, gas supply pressure being too low or improper air-gas mixture caused by incorrect gas valve setting. Only when it is identified that ignition failure is not caused by these reasons, troubleshooting the Spark Igniter is recommended.

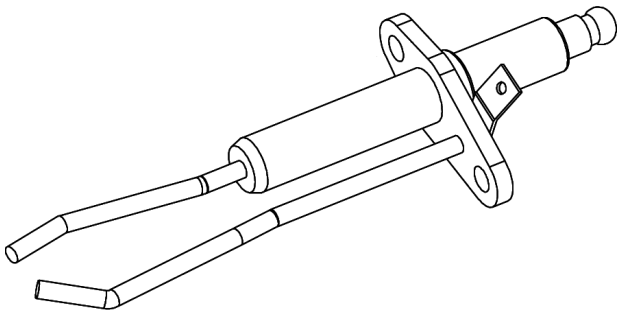


FIGURE 11. SPARK IGNITER

External Ignition System Components:

The three main components of the spark ignition system are the Burner Control Board, the Ignition Transformer and the Spark Igniter. The Burner Control Board sends 120 VAC to the Ignition Transformer during the pre-ignition and startup cycle only. The Ignition Transformer takes the input voltage and outputs the ignition voltage as high as 14 kV to the Spark Igniter for reliable ignition.

Service Notes/Troubleshooting the External Ignition System:

- Turn OFF all the gas supply valves internal and external to the unit (Turn ON only when safe and before ignition tests).
- Identify the pin 6 on the J5 connector block, using a voltmeter measure the volts on this terminal with reference to ground during the pre-ignition/start up cycle of the boiler/water heater. Use the display to exactly time the ignition cycle (Burner state: Pre-ignition, as the sparker does not operate continuously). This should read approximately 115-120 VAC. If the voltage range matches, then the Ignition Transformer or the Spark Igniter could be causing the failure. If there is no voltage during the ignition cycle, then check pin 7 on J5 connector for the supply voltage of 115-120 VAC. The pin 7 on J5 connector is connected to the main power terminals.
- If there is voltage at pin 6 on J5 connector, replace the Ignition Transformer and retest. If it still fails, reaplce the Spark Igniter and test.

GAS VALVE

The 24 Volt Gas Valve on the XB Boilers/XWH water heaters is AC voltage valve. The Control Board sends 24 VAC to the gas valve. See Figure 6 on Page 14.

Gas Valve Voltage Test

- Check for 24 VAC supplied to the 24 Volt Gas Valve at pin 2 of the J5 Connector on the Control Board. Using an "AC" volt meter connect one lead to pin 2 of the J5 Connector and the other lead to ground. 24 VAC should be present.

Gas Valve Removal:

The outlet of the 24 Volt Gas Valve is connected by flange directly to the side of the Venturi and is secured by four - 5/32” hex head screws. A gasket is fitted into the gas valve’s outlet flange. Ensure there is a new gasket on hand before removing the valve. Call the toll free phone number on the back cover of this manual to order parts. Have the complete Model, Series and Serial number (located on the boiler/water heater's rating label) for the boiler/water heater being serviced on hand before calling.

1. Turn off power to the boiler/water heater at the Main Power Supply switch.
2. Loosen the retaining screw for the wiring harness plug on the valve and disconnect the plug.
3. Turn off the supply gas to the boiler/water heater at the main gas shutoff valve.
4. Disconnect the supply gas line to the boiler/water heater at the boiler/water heater's 24 Volt Gas Valve.
5. If the boiler/water heater has been installed in a Direct Vent configuration, disconnect the intake air pipe at the intake air connection on the boiler/water heater.
6. Remove the 4 gas valve mounting screws - 5/32” hex head screws.
7. Carefully lift the 24 Volt Gas Valve body off of the Venturi.
8. Follow these steps in reverse order to reinstall the 24 Volt Gas Valve.
9. Run the boiler/water heater through a complete cycle before leaving to ensure it is operating properly.

Gas Pressure

The boiler/water heater covered in this Service Manual is rated from 920,000 Btu/hr to 3,400,000 Btu/hr input. It is certified for elevations up to 2000 feet (610 meters) for Propane and 10,100 feet (3079 m) for Natural gas. For higher elevations call the toll free support phone number shown on the back cover of this manual for technical assistance.

TABLE 2. GAS PRESSURE

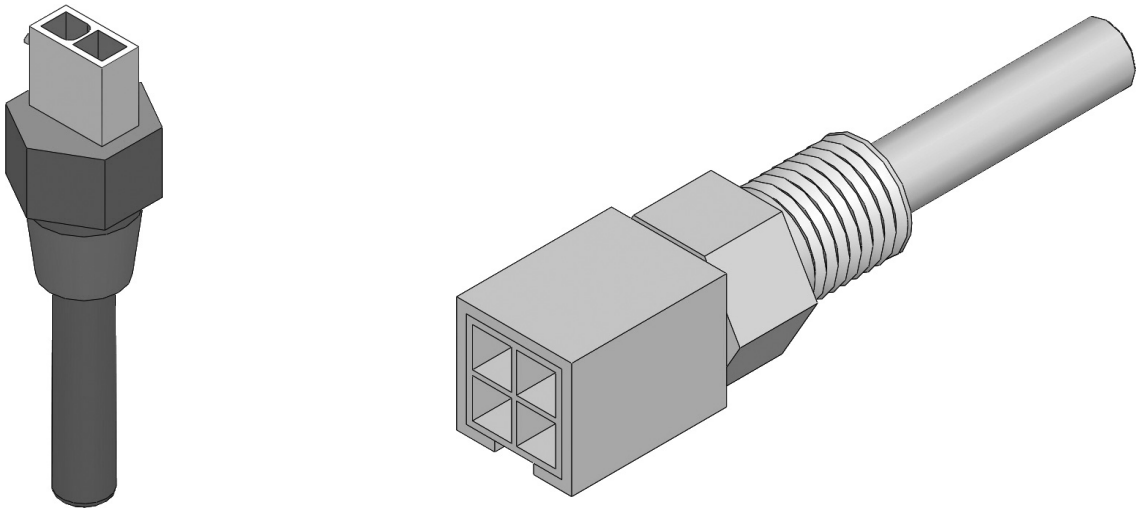
Models (XB/XWH)	Manifold Pressure				Maximum Supply Pressure		Minimum Supply Pressure	
	Type of Gas		Inches W.C.	kPa	Inches W.C.	kPa	Inches W.C.	kPa
1000, 1300, 1700 2000, 2600, 3400	Natural	Min Fire	-0.2 to -0.3	-0.05 to -0.07	14.0	3.49	4.0	1.0
		Max Fire	-3.0 to -3.9	-0.75 to -0.97				
	Propane	Min Fire	-0.1 to -0.3	-0.025 to -0.07	14.0	3.49	4.0	1.0
		Max Fire	-3.6 to -4.9	-0.90 to -1.22				

Service Notes:

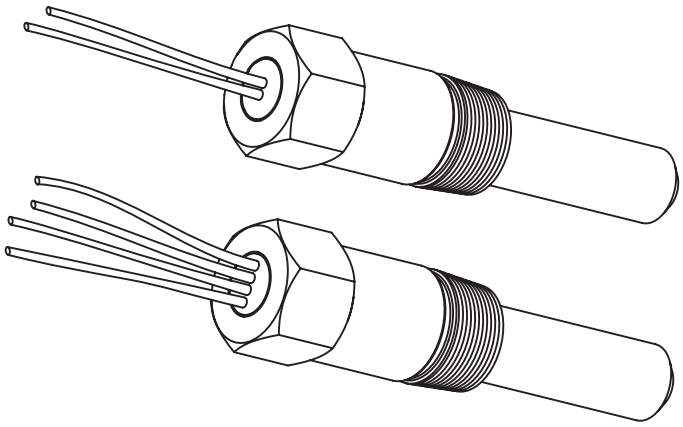
- The manifold gas pressure is factory set and cannot be adjusted in the field.
- The manifold gas pressure and the supply gas pressure can be measured at two pressure test ports on the boiler/water heater’s 24 Volt Gas Valve. The manifold pressure test port is closest to the Combustion Blower. There is a needle valve in each test port that is opened/closed with a small slotted screwdriver. Turn the needle valve counter-clockwise to open the test port valve and clockwise to close it.
- Manifold gas pressure will run close to 0” W.C. or lower (in a vacuum) depending on the current operating state. This pressure will be considerably lower, -0.2” W.C. to -4.9” W.C. during the Pre- Purge and Post-Purge operating states when the Combustion Blower is running at high speed and the 24 Volt Gas Valve is closed.
- There is usually a drop in supply gas pressure noticed when the boiler/water heater’s 24 Volt Gas Valve opens during ignition. Seeing a corresponding rise in manifold pressure during ignition confirms the valve is opening and gas is flowing to the Burner.
- A sustained drop in supply gas pressure of 1.5" W.C. or more during boiler/water heater running may indicate the supply gas line is undersized. If the boiler/water heater is experiencing a sustained drop in supply gas pressure of 1.5" W.C. or more and the boiler/water heater is experiencing repeated Ignition Failure conditions, intermittent loss of flame or rough starting ensure the supply gas line is sized in accordance with the current edition of National Fuel Gas Code (ANSI Z223.1/NFPA 54) or the Natural Gas and Propane Installation Code (CAN/CSA B149.1).

TEMPERATURE SENSORS

Temperature sensors are 3/4 inch male threaded immersion probes. Temperature probes have embedded temperature sensors (thermistors). The boiler/water heater's control system monitors these sensors to determine water temperature at various points in the system. Thermistors are thermally sensitive resistors; as the surrounding temperature rises the resistance of the thermistor (measured in ohms) will decrease and as the surrounding temperature falls the resistance of the thermistor increases. The Boiler/ water heater's Control System monitors these sensors to determine water temperature at various points in the system.



INLET / REMOTE TEMPERATURE PROBE



OUTLET TEMPERATURE PROBE

FIGURE 12. TEMPERATURE SENSORS

Inlet and Outlet Temperature Sensors

All boiler/water heater models have two inlet and two outlet temperature sensors for each heat exchanger, factory installed to monitor the water temperature entering and leaving the boiler/water heater. The Inlet Temperature Probe is a temperature sensor only and has two leads. The Outlet Temperature Probe also contains the manual reset high temperature limit switch and has four leads. The control system displays the Inlet and Outlet water temperatures sensed from these two sensors on the default Temperatures screen.

Remote Sensors

All boiler/water heater models are supplied from the factory with a remote sensor. The remote sensor is used to control system water temperature for a single boiler/water heater in a domestic hot water storage tank or in the return line from a primary/ secondary hydronic heating system.

The boiler/water heater will modulate its firing rate in response to the actual system temperature and load conditions. The control system displays the temperature sensed from the remote sensor as the "Lead Lag" temperature on the default Temperatures screen.

In addition to these sensors the XB hydronic boilers receive an outdoor sensor for monitoring the outdoor temperatures. The outdoor reset functionality is disabled by default and can easily be turned ON at start up.

AIR FILTER ASSEMBLY

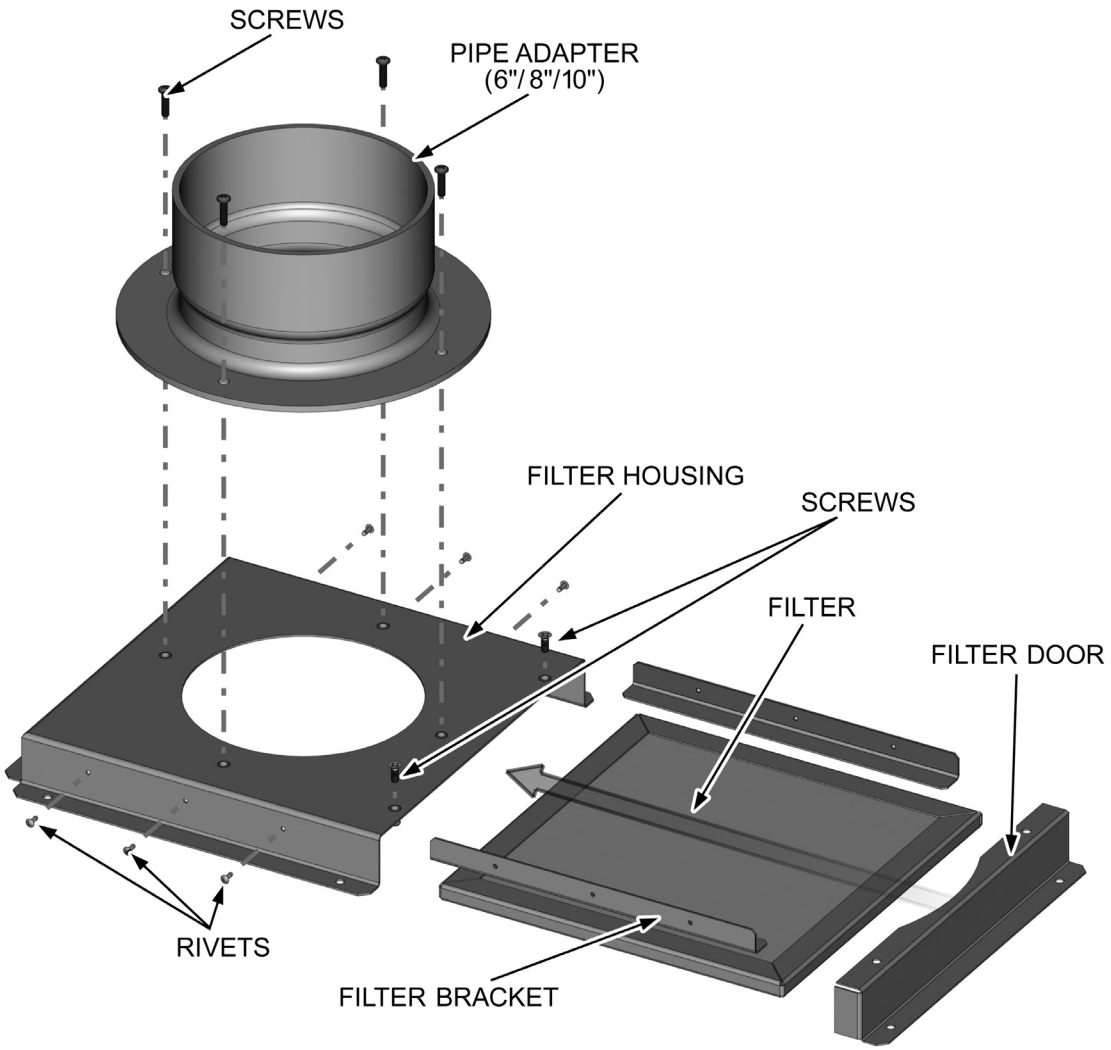


FIGURE 13. AIR FILTER ASSEMBLY

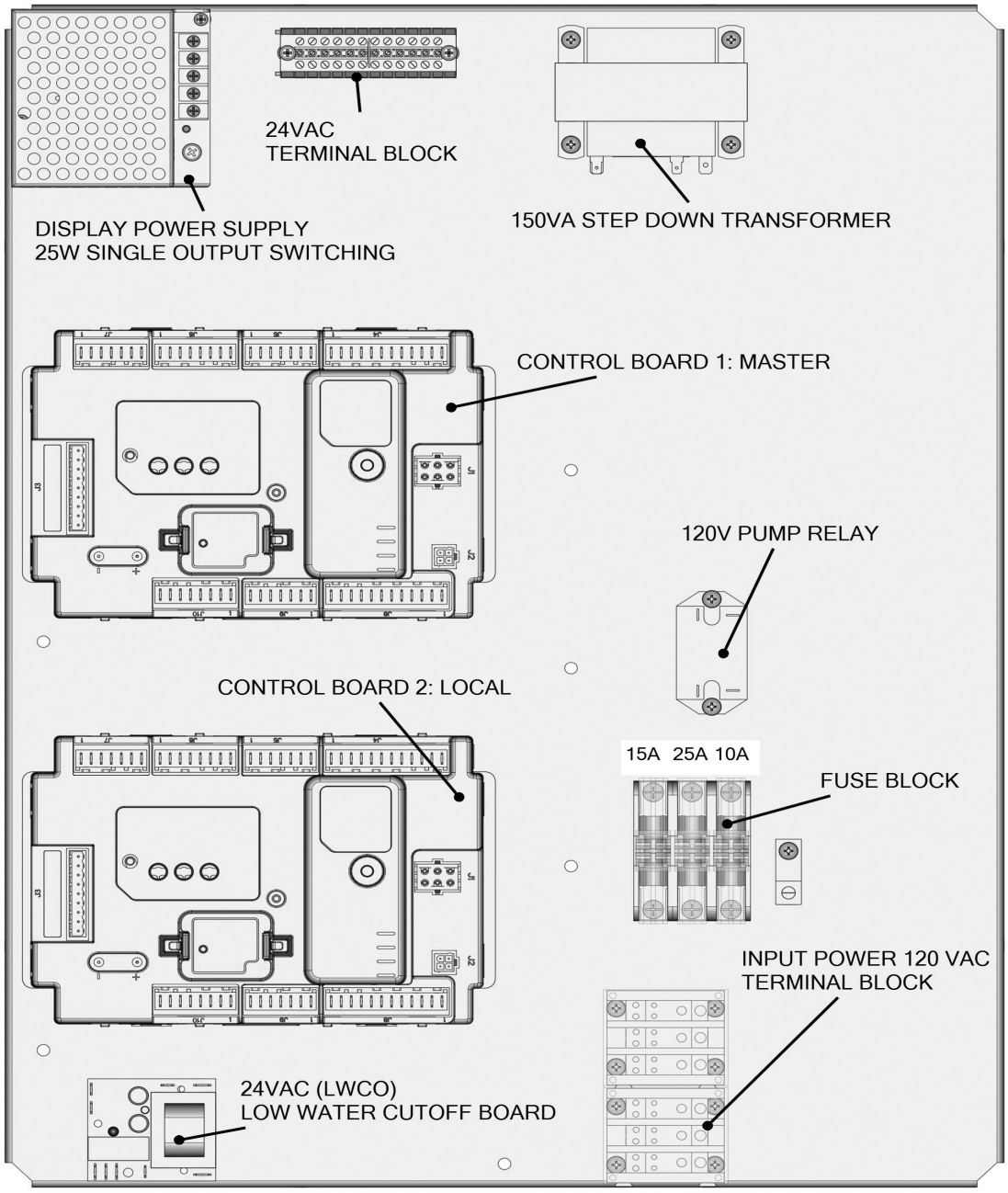
Air Filter Assembly is mounted on the top panel of the XB boilers/ XWH water heaters. See Figure 2 on Page 9 and Figure 3 on Page 10. The assembly includes a filter which slides inside the filter housing and filter brackets. The filter is made of of wire mesh screen and is meant to block dust particles and other debris from entering through the air intake into the boiler/water heater.

Service Notes:

- Ensure the filter is cleaned and water washed every 3 months to avoid the dust and debris getting settled on the filter mesh screen.

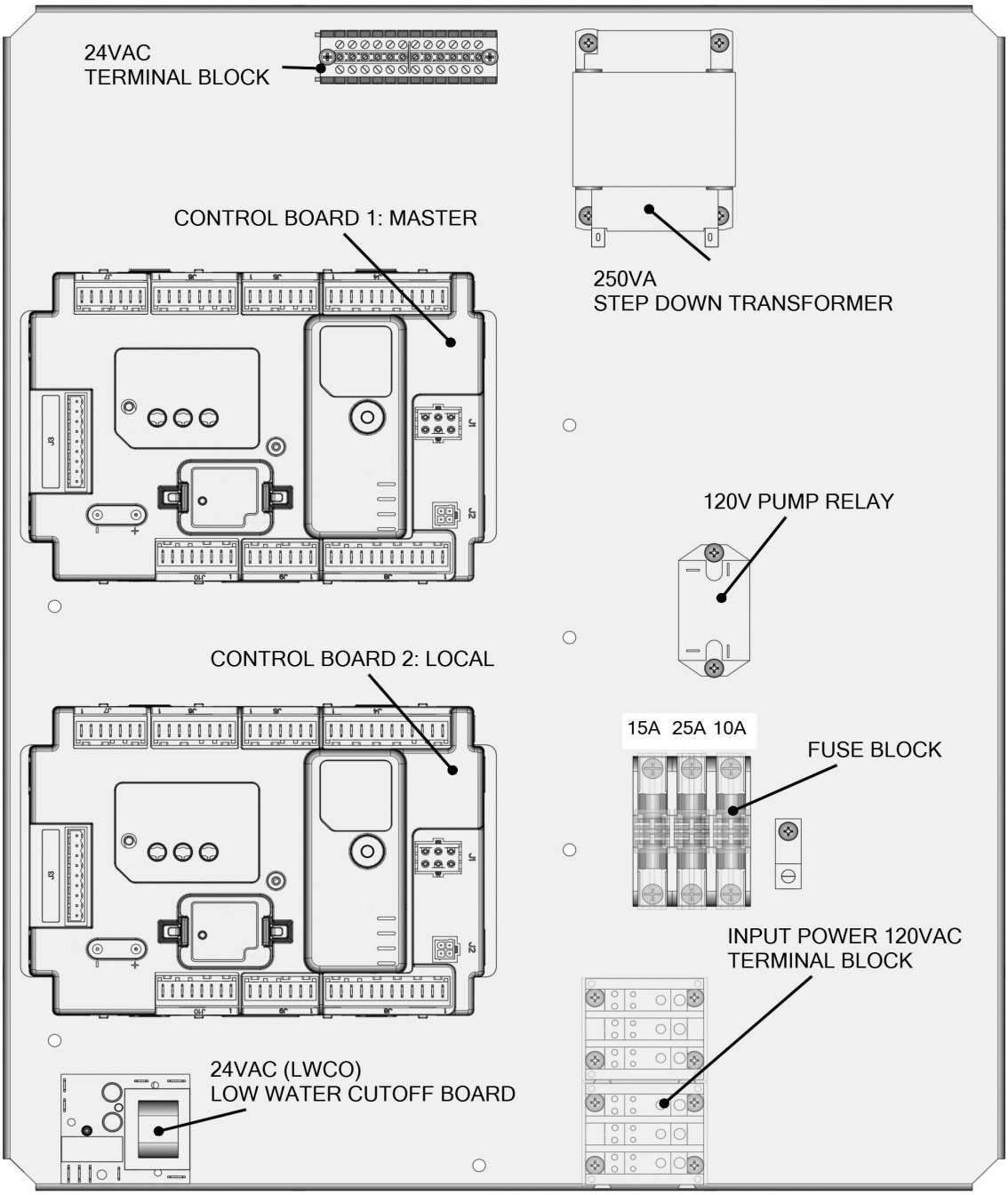
CONTROL PANEL ASSEMBLY

Figure 14, Figure 15 on Page 23 and Figure 16 on Page 24 shows the Control Panels Assemblies for the XB boilers/XWH water heaters. The main components include Control Boards (Master & Local), Display Power Supply, 24 VAC Terminal Block, Step Down Transformer, Pump Relay, Fuse Block, Input Power 120 VAC Terminal Block, Low Water Cutoff Device and Interlock/Load Control Input (ILK/LCI) Relays.



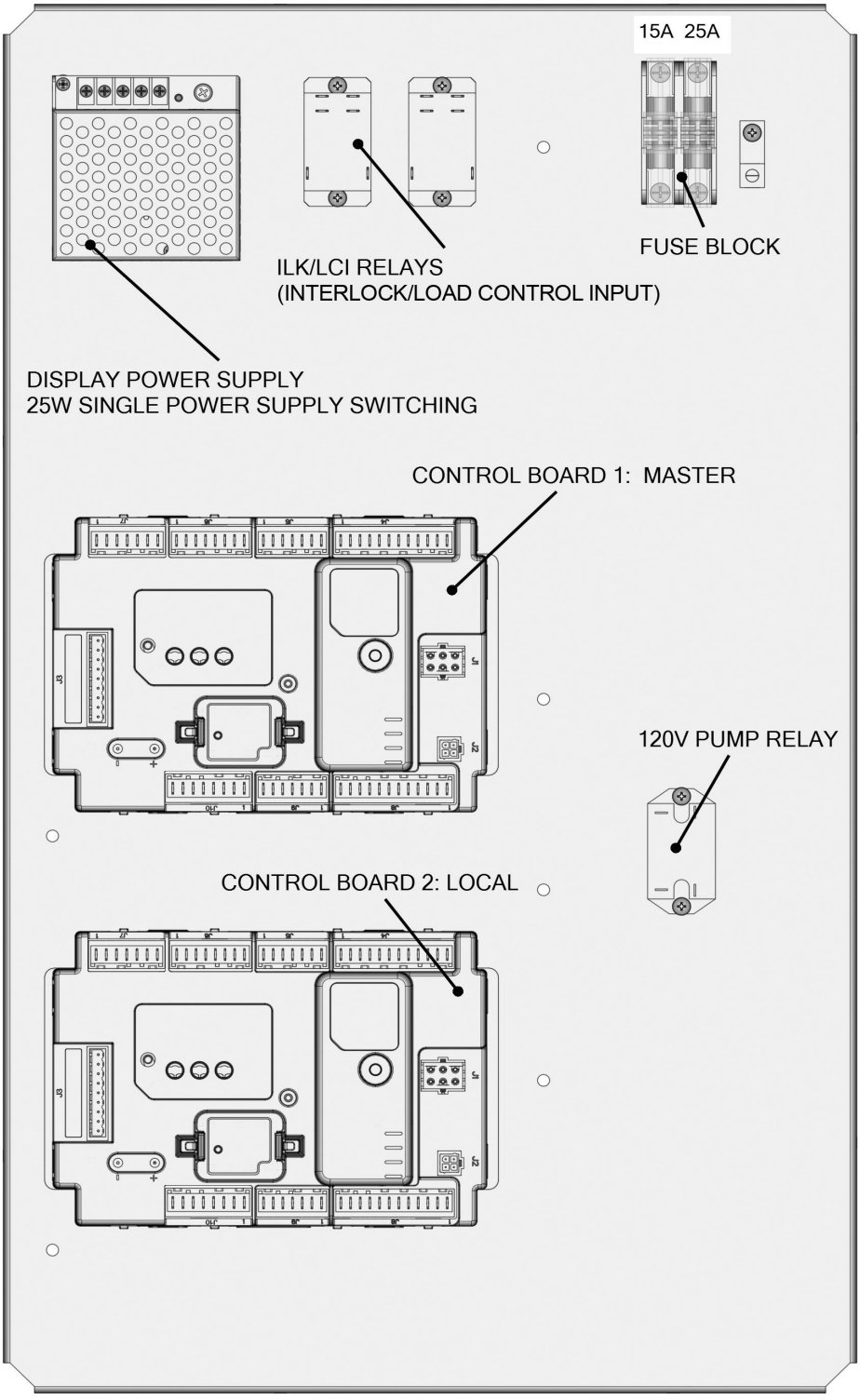
CONTROL PANEL ASSEMBLY (1000/1300/1700)

FIGURE 14. CONTROL PANEL ASSEMBLY (1000/1300/1700)



UPPER CONTROL PANEL ASSEMBLY (2000/2600/3400)

FIGURE 15. UPPER CONTROL PANEL ASSEMBLY (2000/2600/3400)



LOWER CONTROL PANEL ASSEMBLY (2000/2600/3400)

FIGURE 16. LOWER CONTROL PANEL ASSEMBLY (2000/2600/3400)

CONTROL BOARD ASSEMBLY

The Control Board assembly provides heat control, flame supervision, circulation pump control, fan control, boiler/water heater control sequencing, and electric ignition function. It will also provide boiler/water heater status and error reporting. The Control Board may consist of Control Device, Touchscreen Display (required for setup and ModBus communication, but not required for the system to operate once the Control Device is programmed), Local Operator Interface (which can set up and monitor the Control Device), Local Keyboard Display Module, Flame Rod, Temperature Sensor (NTC Type 10KΩ at 77°F (25°C) or 12KΩ at 77°F (25°C)), Limit Sensor (NTC Type 10KΩ at 77°F (25°C)) and Fans (VFD).

INPUTS

Analog Inputs:

1. NTC Sensor Imputs (10kohm or 12kohm)

NOTE: 12kohm and 10kohm single sensors cannot be used for Limit Application functions (10kohm dual sensors only).

2. Hydronic Control
   - Outlet Limit and Temperature
   - Stack Limit and Temperature
   - Inlet Temperature
   - Outdoor Temperature
3. Other Analog Inputs
   - PWM Feedback
   - Flame Signal from either a Flame Rod or Ultraviolet Detector
   - 4-20mA Control Input, Remote Setpoint, Remote Firing Rate

Digital Inputs:

1. LCI (Load [or Limit] Control Input)
2. Interlock
3. Annunciation

OUTPUTS

Analog Outputs:

1. Modulation
   - 4-20mA
   - 0-10 VDC
   - PWM for Variable Frequency Drives

Digital Outputs:

1. Auxiliary Output Control
   - Hydronic Control for Pumps 3 outputs, 5 different programmable features
2. Combustion Blower
3. External Ignition
4. Gas Valve
5. Alarm

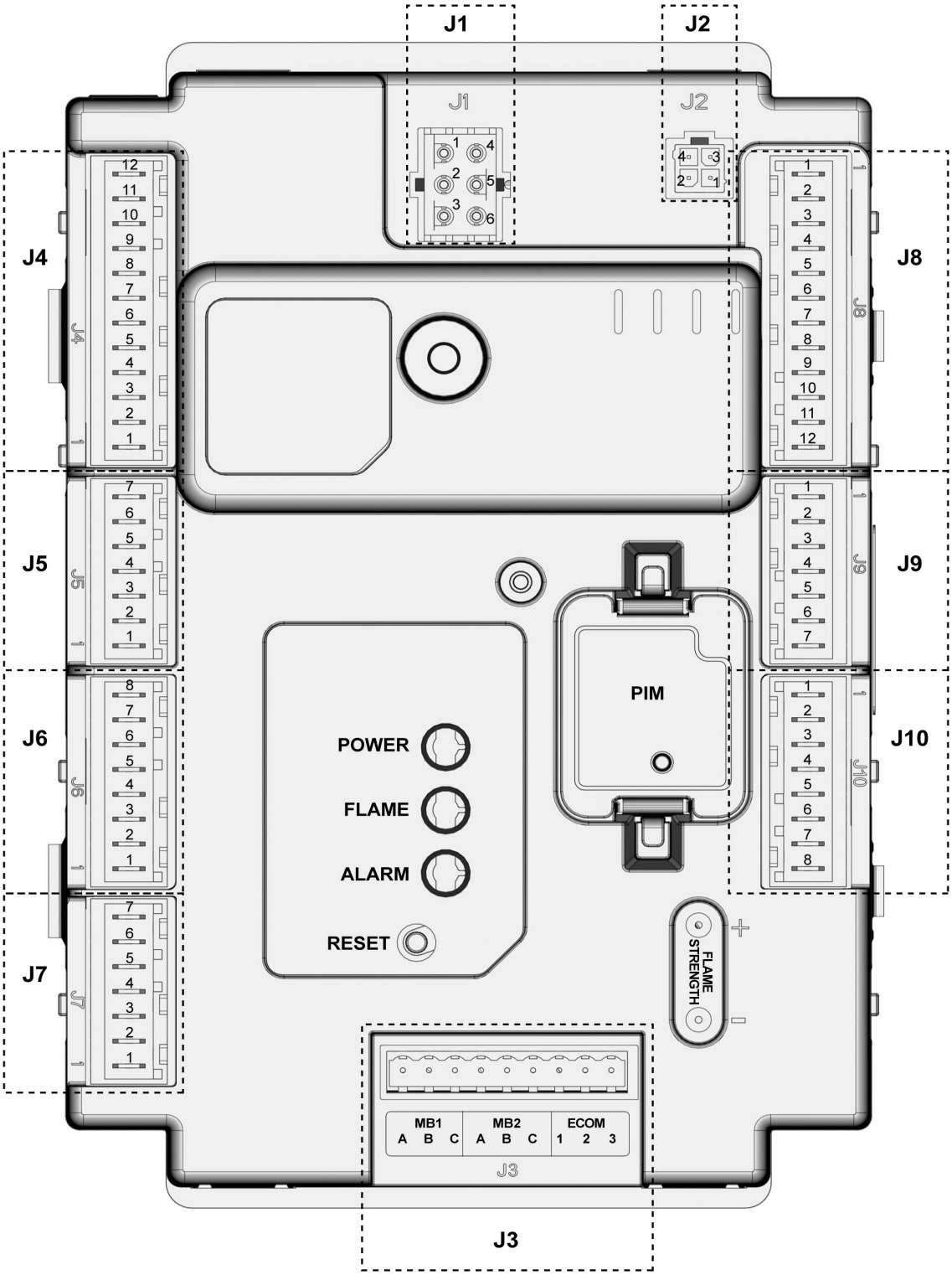


FIGURE 17. CONTROL BOARD ASSEMBLY

TABLE 3. CONTROL BOARD CONTACTS/CONNECTIONS

CONNECTORS	PINS	TERMINOLOGY	DESCRIPTION AND RATING
J1	1	Not Used	
	2	FLAME SENSE1/2: SENSE	Flame Rod Input.
	3	FLAME SENSE1/2: GND	Flame Rod Common.
	4	Not Used	
	5	Not Used	
	6	Not Used	
J2	1	TACH	Tachometer Input (Tach).
	2	25VDC	Electronic Blower Motor Power (25 VDC).
	3	PWM	Digital modulation (PWM) Output Digital modulation signal out.
	4	GND	Ground pin for Fan interface and power.
J3	MB1	A	Modbus MB1 RS-485 +. Connects to Display.
		B	Modbus MB1 RS-485 -. Connects to Display.
		C	Modbus MB1 Ground (G). Connects to Display.
	MB2	A	Modbus MB2 RS-485 +. Connects to Local Burner Control Board for Lead lag application.
		B	Modbus MB2 RS-485 -. Connects to Local Burner Control Board for Lead lag application.
		C	Modbus MB2 RS-485 Ground (G). Connects to Local Burner Control Board for Lead lag application.
	ECOM	1: Not Used	
		2: Not Used	
		3: Not Used	
J4	1	Not Used	
	2	Not Used	
	3	Not Used	
	4	Not Used	
	5	Not Used	
	6	PUMP1/PUMP Output	120 VAC Power output to Pump Relay.
	7	H_PUMP/PUMP Input	120 VAC Power input from Power Distribution Block.
	8	Not Used	
	9	Not Used	
	10	SOLA1_L_RTN	120 VAC Power Supply Neutral.
	11	Not Used	
	12	G/EARTH GROUND	Earth Ground.
J5	1	INTERLOCK/BFS	Blocked Flue Switch. Per Model Input Rating.
	2	GV1	24VAC Power input to the Gas Valve.
	3	Not Used	
	4	Not Used	
	5	Not Used	
	6	SPARK_G1	120 VAC Power output to Spark Generator.
	7	H_BLOW_SPRK	120 VAC Power input from Power Distribution Block.
J6	1	LWCO	Annunciator for LWCO Input.
	2	Not Used	
	3	FLOW_SW	Annunciator for Flow Switch Input.
	4	Not Used	
	5	Not Used	
	6	Not Used	
	7	Not Used	
	8	Not Used	

CONNECTORS	PINS	TERMINOLOGY	DESCRIPTION AND RATING
J7	1	SIPHON	Condensation Switch Input.
	2	F1	Flapper Switch Input.
	3	Not Used	
	4	SYS_ENABLE	Annunciator for System Enable Switch.
	5	LGP	Annunciator for Low Gas Pressure Switch.
	6	HGP	Annunciator for High Gas Pressure Switch.
	7	Not Used	
J8	1	SOLA1_PWR	24VAC Power Input form Terminal Block.
	2	SOLA1_S_RTN	24VAC Return Input from Terminal Block.
	3	Not Used	
	4	INLET TEMP	Supply for, and signal input from 10K or 12K Ohm NTC Inlet Temperature sensor. Connects to Pin 2 on Inlet Temperature Sensor.
	5	INLET TEMP Common	Ground reference for the Inlet Temperature Sensor. Connects to Pin 1 on Inlet Temperature Sensor.
	6	Not Used	
	7	Not Used	
	8	OUTLET TEMP	Supply for, and signal input from 10K or 12K Ohm NTC Outlet Temperature Sensor. Connects to Pin 2 on Outlet Temperature Sensor.
	9	OUTLET TEMP Common	Ground reference for the Outlet Temperature Sensor. Connects to Pins 3 & 4 on Outlet Temperature Sensor.
	10	OUTLET TEMP	Supply for, and signal input from 10K Ohm NTC Outlet Temperature Sensor. Connects to Pin 1 on Outlet Temperature Sensor.
	11	HEADER +	Supply for, and signal input from 10K or 12K Ohm NTC Header Sensor.
	12	HEADER -	Ground reference for the Header Sensor.
J9	1	Not Used	
	2	Not Used	
	3	Not Used	
	4	STACK TEMP	Supply for, and signal input from 10K or 12K Ohm NTC Flue Sensor. Connects to Pin 2 on Flue Sensor.
	5	STACK Common	Ground reference for the Flue Sensor. Connects to Pin 3 & 4 on Flue Sensor.
	6	STACK TEMP/Heat Exchanger Unit)	Supply for, and signal input from 10K Ohm NTC Flue Sensor. Connects to Pin 1 on Flue Sensor.
	7	Not Used	
J10	1	REMOTE RESET	Open/Ground Input that has functionality corresponding to pushing/releasing the local reset.
	2	TOD (Time of Day)	Open/Ground Input which switches operating set points.
	3	TOD/REMOTE RESET COMMON	Ground reference for time of day and remote reset inputs.
	4	MODULATION 4 - 20mA (+) (Out)	4 to 20 mA Current modulation signal out into a 600 Ohm.
	5	MODULATION 0 - 10 VDC (+) (Out)	0 to 10 VDC Voltage modulation signal out, 10 mA max.
	6	MODULATION COMMON (-)	Ground reference for voltage and current modulation signals.
	7	Not Used	
	8	Not Used	

SPECIAL CONNECTIONS			
Flame +	FS +	Testpoint for Flame signal. 0 to 10 VDC	
Flame -	FS -	Testpoint for Flame signal - Ground reference.	

DISPLAY SYSTEM (TOUCH SCREEN DISPLAY)

The Display System is a microprocessor-based color touchscreen Operator Interface (OI) display that provide an operator interface for monitoring and configuring parameters such as burner control sequence, flame signal, diagnostics, historical files, and faults in the Control System. It can be used to monitor an individual boiler/water heater but is primarily used for multiple boiler/water heater applications in a lead/lag arrangement. Wiring connections to the Display System are through a removable 8-pin wiring header.

Electrical Ratings:

1. Input Voltage: 18 – 30 Vac (24Vac nominal), 50/60 Hz.
2. Input Current: 500 mA max.
3. Power consumption: 12W max.
4. Operating Temperature: -4 to 158 ºF (-20 to 70 ºC)
5. Storage/Shipping Temperature: -22 to 176 ºF (-30 to 80 ºC)
6. Humidity: 90% RH, non-condensing.
7. Enclosure rating: IP10 / NEMA 1
8. Approvals:
   - FCC Part 15, Class A Digital Device.
   - Underwriter's Laboratories, Inc. (UL) (cUL) Component Recognized (for non-continuous operation): File Number MH17367 (MJAT2, MJAT8).

CONNECTOR TERMINALS

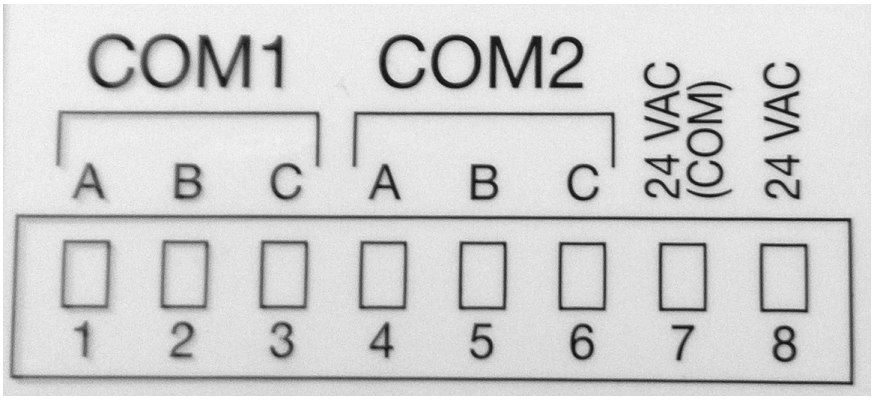


FIGURE 18. DISPLAY CONNECTOR TERMINALS

The Display System must be appropriately wired for both power and communications.

The communication is done over two RS-485 bus:

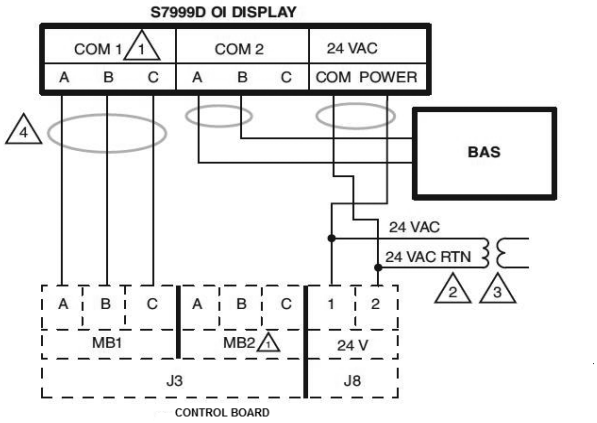
- COM1 is connected directly to the Control Board J3 connector to either Modbus (MB1 or MB2).
- COM2: A bus to the Building Automation System.

Refer to the Table 4 for 8-pin Connector Terminals.

TABLE 4. 8-PIN CONNECTOR TERMINALS

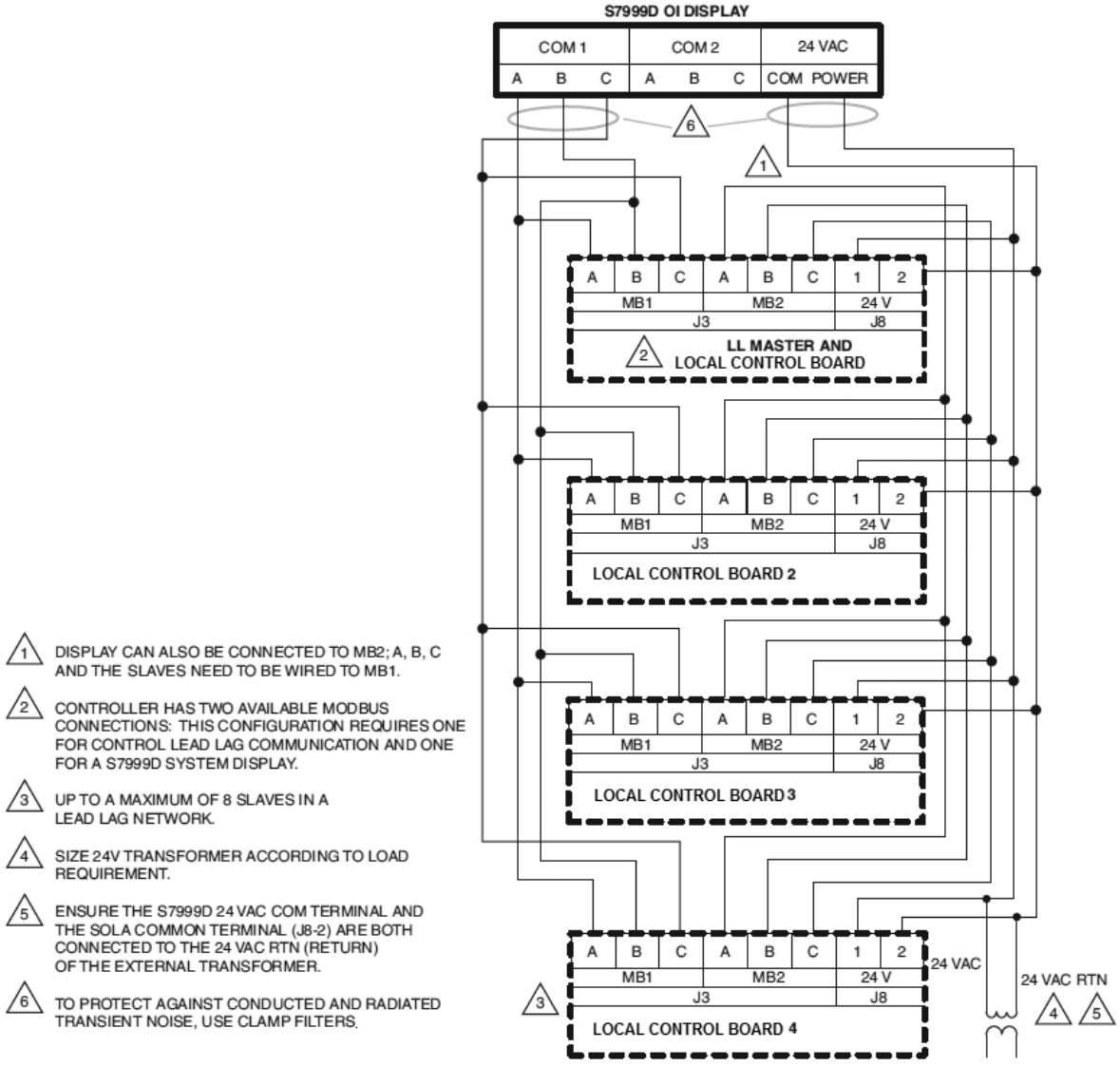
PIN #	FUNCTION
1	COM1 A
2	COM1 B
3	COM1 C*
4	COM2 A
5	COM2 B
6	COM2 C*
7	24 VAC Common*
8	24 VAC Power

* These 3 terminals are connected internally and can be connected to earth ground.



1. COM PORTS ARE NOT RESTRICTED TO A SPECIFIC DEVICE, BUT CAN BE CONNECTED TO CONTROLS OR BAS SYSTEM. DISPLAY CAN BE CONNECTED TO MB2.
2. SIZE 24V TRANSFORMER ACCORDING TO LOAD REQUIREMENT.
3. ENSURE THE S7999D 24 VAC COM TERMINAL AND THE COMMON TERMINAL (J8-2) ARE BOTH CONNECTED TO THE 24 VAC RTN (RETURN) OF THE EXTERNAL TRANSFORMER.
4. TO PROTECT AGAINST CONDUCTED AND RADIATED TRANSIENT NOISE, USE CLAMP FILTERS.

FIGURE 19. DISPLAY CONNECTOR TERMINALS SCHEMATIC DIAGRAM



1. DISPLAY CAN ALSO BE CONNECTED TO MB2; A, B, C AND THE SLAVES NEED TO BE WIRED TO MB1.
2. CONTROLLER HAS TWO AVAILABLE MODBUS CONNECTIONS: THIS CONFIGURATION REQUIRES ONE FOR CONTROL LEAD LAG COMMUNICATION AND ONE FOR A S7999D SYSTEM DISPLAY.
3. UP TO A MAXIMUM OF 8 SLAVES IN A LEAD LAG NETWORK.
4. SIZE 24V TRANSFORMER ACCORDING TO LOAD REQUIREMENT.
5. ENSURE THE S7999D 24 VAC COM TERMINAL AND THE SOLA COMMON TERMINAL (J8-2) ARE BOTH CONNECTED TO THE 24 VAC RTN (RETURN) OF THE EXTERNAL TRANSFORMER.
6. TO PROTECT AGAINST CONDUCTED AND RADIATED TRANSIENT NOISE, USE CLAMP FILTERS.

FIGURE 20. DISPLAY CONNECTOR TERMINALS LEAD LAG DIAGRAM

START UP AND OPERATIONS

PRIOR TO START UP

In addition to normal supplies and hand tools necessary for installing and servicing the boilers/water heaters, other tools and test equipment should be on hand. See Tools Required on Page 4 for detailed tool requirements.

Only an A. O. Smith Certified Start-up agent must perform the initial firing of the boiler/water heater. At this time the user should not hesitate to ask the start-up agent any questions regarding the operation and maintenance of the unit. If you still have questions, please contact the factory or your local A. O. Smith representative. Contact Technical Support noted on the back cover for the name of your closest Certified Start-up Agent.

GENERAL

Never operate the boiler/water heater without first making sure the boiler/water heater and system are filled with water, in addition:

- Make sure a temperature and pressure relief valve is installed in the storage tank for hot water supply installations.
- Make sure that the boiler/water heater and system have been purged of air and checked for leaks.

Also ensure to check the gas piping for leaks before beginning the initial firing of the boiler/water heater.

FILLING AND PURGING OF BOILER/WATER HEATER INSTALLATION

1. Fast fill system through bypass until pressure approaches desired system pressure. Close bypass valve and permit pressure to be established by the pressure reducing valve.
2. Vent all high points in system to purge system of air.

Provisions should be made to permit manual venting of radiators or convectors. Gas line purging is required with new piping or systems in which air has entered.

FILLING BOILER/WATER HEATER INSTALLATION

1. Close the system's drain valve by turning handle clockwise.
2. Open a nearby hot water faucet to permit the air to escape.
3. Fully open the cold water inlet pipe valve allowing the boiler/water heater and piping to be filled.
4. Close the hot water faucet as water starts to flow.

INLET GAS PRESSURE

The inlet gas pressure is measured by removing the 1/8" NPT Plug located on the upstream side of the supply gas valve, and inserting a 1/8" NPT hose barb fitting to be connected to a manometer or pressure gauge. Once pressure has been checked and/or adjusted, replace the plug and check for leaks. The maximum value specified must not be exceeded. The minimum values must be maintained under both load and no load conditions (static and firing conditions). Refer to Instruction Manual of this boiler/water heater for pressure values. The combination gas valves supplied with the boiler/water heater are for low pressure service. If upstream pressure exceeds 14.0" W.C., an intermediate gas pressure regulator of the lockup type must be installed.

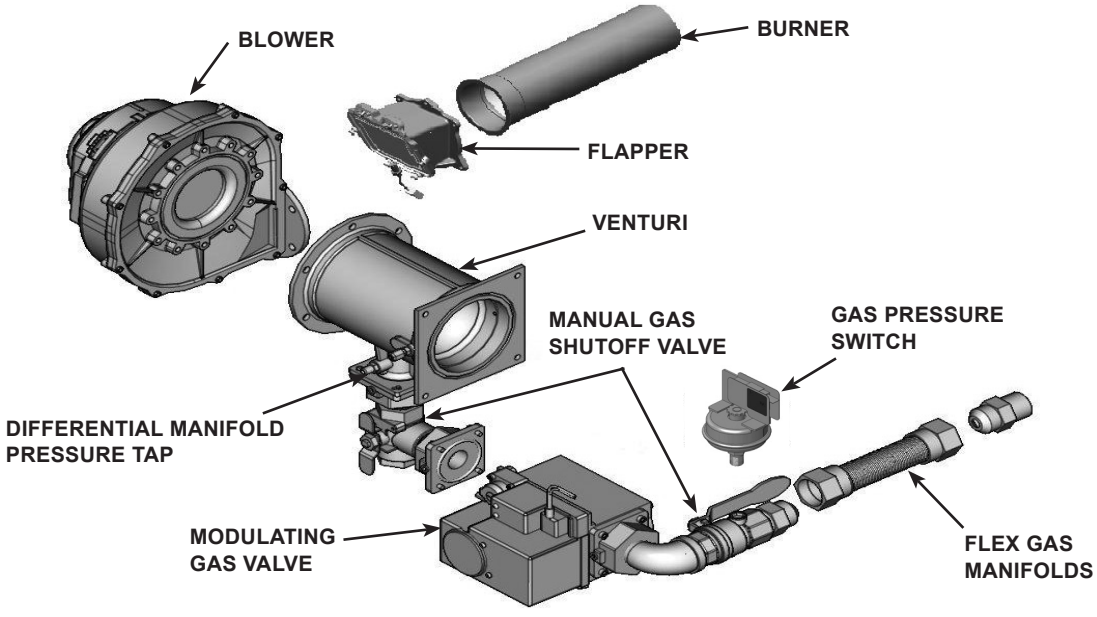


FIGURE 21. GAS TRAIN ASSEMBLY

MANIFOLD PRESSURE CONNECTIONS

Check the manifold pressure (refer to Table 2 on Page 19) by removing the pipe plug (located on the back of the boiler/water heater near the main gas shutoff valve) and inserting a suitable 1/8" NPT hose barb for connection to the manometer/pressure gauge. Upon completion of measurements and adjustments, remove the hose barb and replace the pipe plug. Check for gas leaks and insure all connections are gas tight. The draft pressures can range in between 0.05" - 1.5" W.C. And the static to dynamic pressures may vary in the range of 2" - 5" W.C. depending on the boiler/water heater models.

⚠ CAUTION

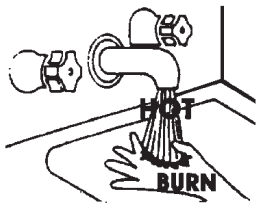
Gas Supply

Should overheating occur or the gas supply fail to shut off, turn off the gas supply at a location external to the boiler (i.e., main manual gas shutoff valve).

Light the boiler in accordance with the instructions provided on the label affixed to the boiler's front door on the inside.

WATER TEMPERATURE REGULATION

⚠ DANGER



Untempered hot water can cause severe burns instantly resulting in severe injury or death.

Children, elderly, and the physically or mentally disabled are at highest risk for scald injury.

Feel water before bathing or showering. Temperature limiting valves are available.

Read instruction manual for safe temperature setting.

HOT WATER CAN SCALD: Boilers/water heaters are intended to produce hot water. Water heated to a temperature which will satisfy space heating, clothes washing, dish washing and other sanitizing needs can scald and permanently injure you upon contact. Some people are more likely to be permanently injured by hot water than others. These include the elderly, children, the infirm or physically/mentally disabled. If anyone using hot water in your home fits into one of theses groups or if there is a local code or state law requiring a specific temperature water at the hot water tap, then you must take special precautions. In addition to using the lowest possible temperature setting that satisfies your hot water needs, a means such as a mixing valve should be used at the hot water taps used by these people or at the hot water supply tank. Mixing valves are available at plumbing supply or hardware stores. Follow the manufacturer's instructions for installation of the valves. Before changing the thermostat setting on the hot water system controller, refer to Table 5.

Hot water temperatures required for automatic dishwasher and laundry use can cause scald burns resulting in serious personal injury and/or death. The temperature at which injury occurs varies with the person's age and time of exposure. The slower response time of children, aged or disabled persons increases the hazards to them. Never allow small children to use a hot water tap, or to draw their own bath water. Never leave a child or disabled person unattended in a bathtub or shower. The boiler/water heater should be located in an area that is inaccessible to the general public.

TABLE 5. RISK OF SCALDS

Water Temperature °F	Time for 1st Degree Burns (Less Severe Burns)	Time for Permanent Burns 2nd & 3rd (Most Severe Burns)
110	(normal shower temp.)	
116	(pain threshold)	
116	35 minutes	45 minutes
122	1 minute	5 minutes
131	5 seconds	25 seconds
140	2 seconds	5 seconds
149	1 second	2 seconds
154	instantaneous	1 second
(U.S. Government Memorandum, C.P.S.C., Peter L. Armstrong, Sept. 15,1978)		

Should overheating occur or the gas supply fail to shut off, turn off the main manual gas shutoff valve to the boiler/water heater.

CHECK/CONTROL WATER HARDNESS

XWH water heaters are approved for use in Domestic Water Heating Systems with a water supply hardness of 0 grains per gallon to a maximim of 12 grains per gallon and a Total Dissolved Solids (TDS) not exceeding 350 PPM. Heating water having higher grains/TDS specified here requires larger circulating pump. Consult manufacturer when heating water exceeding these specs. Refer to Table 6 for recommend flow rate to maintain scale free operation with up to a medium water hardness. For scale free operation in hard water systems with a water hardness greater than 12 grains per gallon, a water softener must be installed and maintained.

TABLE 6. WATER HARDNESS MEDIUM (0-12 GRAINS PER GALLON)

XW MODEL NO.	∆T ºF	GPM (LPM)	∆P FEET
1000	25	76 (287.6)	17.5
1300	25	99 (374.7)	22
1700	25	129 (488.2)	23
2000	25	152 (575.3)	17.5
2600	25	198 (749.4)	22
3400	25	258 (976.53)	23

∆T ºF = Temperature rise ºF at the specified GPM.

GPM = Flow rate in gallons per minute.

∆P = Pressure loss through the heat exchanger in feet of head.

For systems over 5 grains per gallon; and for scale free operation, boiler/water heater setpoint should not exceed 140 ºF.

Note: The factory installed/supplied pump on the above listed models of boilers/water heaters is sized to maintian a 25 ºF ∆**T** through the boiler/water heater when the boiler/water heater is firing at 100% fire.

In addtion to the pressure loss through the heat exchanger, the factory supplied pump is sized for an additional 50 feet (15.2 m) of equivalent feet of piping between the boiler/water heater and a storage tank. All piping between the boiler/water heater and the storage tank must be of a pipe size equal to the inlet/outlet(s) of the boiler/water heater. Installation differences may slightly change these parameters.

FREEZE PROTECTION (HYDRONIC HEATING INSTALLATION)

1. Determine freeze protection fluid quantity using system water content, following fluid manufacturer's instructions.
2. Local codes may require a backflow preventer or actual disconnect from city water supply.
3. When using freeze protection fluid with automatic fill, install a water meter to monitor water makeup. Freeze protection fluid may leak before the water begins to leak, causing concentration to drop, reducing the freeze protection level.

INSPECT/FILL CONDENSATE SYSTEM

Inspect/check condensate lines and fittings:

1. Inspect the condensate drain line, condensate PVC fittings and condensate trap. Repair any leaks.

Fill condensate trap with water:

1. Remove the 2 inch PVC cap with the switch located at the top of the trap.
2. Fill with fresh water until the water begins to pour out of the drain.
3. Replace the cap. Press the cap onto the trap until the cap makes contact with the drain.

The condensate trap must be filled with water during all times of boiler/water heater operation to avoid flue gas emission from the condensate drain line. Failure to fill the trap could result in severe personal injury or death.

LIGHTING AND OPERATING INSTRUCTIONS

FOR YOUR SAFETY READ BEFORE OPERATING

WARNING: IF YOU DO NOT FOLLOW THESE INSTRUCTIONS EXACTLY, A FIRE OR EXPLOSION MAY RESULT CAUSING PROPERTY DAMAGE, PERSONAL INJURY OR LOSS OF LIFE.

FLAMMABLE

A. THIS APPLIANCE DOES NOT HAVE A PILOT. IT IS EQUIPPED WITH AN IGNITION DEVICE WHICH AUTOMATICALLY LIGHTS THE BURNER. DO NOT TRY TO LIGHT THE BURNER BY HAND.

B. BEFORE LIGHTING: SMELL ALL AROUND THE APPLIANCE AREA FOR GAS. BE SURE TO SMELL NEXT TO THE FLOOR BECAUSE SOME GAS IS HEAVIER THAN AIR AND WILL SETTLE ON THE FLOOR.

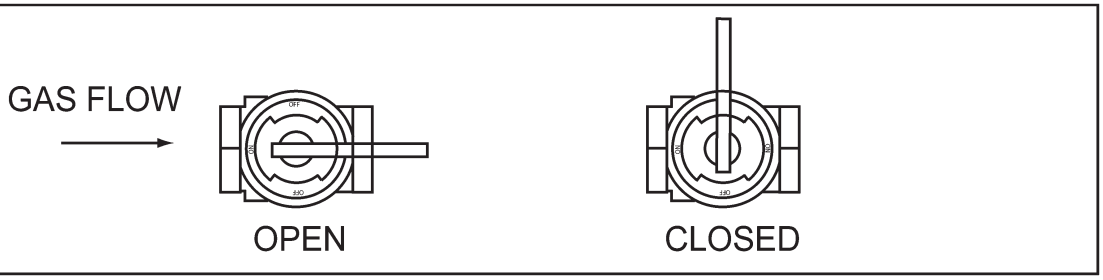
WHAT TO DO IF YOU SMELL GAS

- DO NOT TRY TO LIGHT ANY APPLIANCE.
- DO NOT TOUCH ANY ELECTRIC SWITCH;
- DO NOT USE ANY PHONE IN YOUR BUILDING.
- IMMEDIATELY CALL YOUR GAS SUPPLIER FROM A NEIGHBOR'S PHONE. FOLLOW THE GAS SUPPLIER'S INSTRUCTIONS.
- IF YOU CAN NOT REACH YOUR GAS SUPPLIER, CALL THE FIRE DEPARTMENT.

C. USE ONLY YOUR HAND TO TURN THE MAIN MANUAL GAS VALVE. NEVER USE TOOLS. IF THE KNOB WILL NOT PUSH IN OR TURN BY HAND, DON'T TRY TO REPAIR IT. CALL A QUALIFIED SERVICE TECHNICIAN. FORCE OR ATTEMPTED REPAIR MAY RESULT IN A FIRE OR EXPLOSION.

D. DO NOT USE THIS APPLIANCE IF ANY PART HAS BEEN UNDER WATER. IMMEDIATELY CALL A QUALIFIED SERVICE TECHNICIAN TO INSPECT THE APPLIANCE AND TO REPLACE ANY PART OF THE CONTROL SYSTEM AND ANY GAS CONTROL WHICH HAS BEEN UNDER WATER.

E. DO NOT OPERATE APPLIANCE UNLESS UNIT IS FILLED WITH WATER AND WATER LINES ARE FULLY OPEN.



OPERATING INSTRUCTIONS

1. STOP! READ THE SAFETY INFORMATION ABOVE ON THIS LABEL.
2. SET SYSTEM TEMPERATURE CONTROLLER TO LOWEST SETTING.
3. TURN OFF ELECTRIC POWER TO THE BOILER.
4. CLOSE MAIN VALVE. TURN MAIN MANUAL GAS VALVE TO "OFF" OR CLOSED POSITION. THE VALVE IS "OFF" WHEN THE HANDLE IS PERPENDICULAR TO THE GAS FLOW DIRECTION.
5. WAIT FIVE (5) MINUTES TO CLEAR OUT ANY GAS. THEN SMELL FOR GAS, INCLUDING NEAR THE FLOOR. IF YOU SMELL GAS STOP! FOLLOW "B" IN THE SAFETY INFORMATION ABOVE ON THIS LABEL. IF YOU DO NOT SMELL GAS, GO TO THE NEXT STEP.
6. OPEN MAIN VALVE. TURN MAIN GAS VALVE TO "ON" OR OPEN POSITION. THE VALVE IS IN THE "ON" POSITION WHEN THE HANDLE IS PARALLEL TO THE GAS FLOW DIRECTION.
7. THIS APPLIANCE IS EQUIPPED WITH AN IGNITION DEVICE WHICH AUTOMATICALLY LIGHTS THE BURNER. DO NOT TRY TO LIGHT THE BURNER BY HAND.
8. TURN ON POWER TO THE APPLIANCE.
9. SET SYSTEM TEMPERATURE CONTROLLER TO DESIRED OPERATING TEMPERATURE.
10. IF THE APPLIANCE WILL NOT OPERATE, FOLLOW THE INSTRUCTIONS" TO TURN OFF GAS TO APPLIANCE". CALL YOUR SERVICE TECHNICIAN OR GAS SUPPLIER.

TO TURN OFF GAS TO APPLIANCE

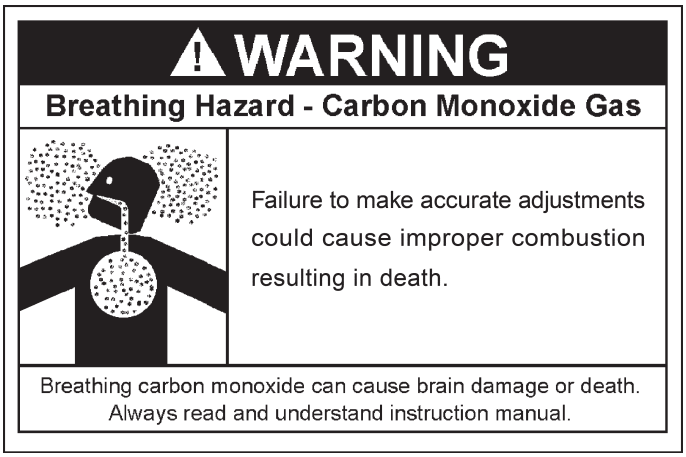
A. SET SYSTEM TEMPERATURE CONTROLLER TO LOWEST SETTING.

B. TURN OFF ELECTRICAL POWER TO BOILER.

C. CLOSE MAIN VALVE. TURN MAIN MANUAL GAS VALVE TO "OFF" OR CLOSED POSITION. THE VALVE IS IN THE "OFF" POSITION WHEN THE HANDLE IS PERPENDICULAR TO THE GAS FLOW DIRECTION.

Servicing should only be performed by a Qualified Service Agent

ADJUSTMENT



There must be sufficient load to operate the boiler/water heater at high fire to perform the following adjustments. Start the boiler/water heater and observe proper operating parameters for the system.

Required Tools:

- TORX® T40 or 5 mm hex wrench
- 3 mm or 7/64 inch hex wrench
- Combustion analyzer

These boilers/water heaters are equipped with a Honeywell combined gas/air control and gas safety shut off control valves. The valve functions in parallel with the variable speed combustion blower to supply the correct gas air ratio for optimum performance and efficiency. The combustion blower speed is controlled automatically and determines the amount of negative pressure experienced by the gas safety shut off/control valves. The gas/air regulator adjusts gas flow to maintain the proper pressure at the outlet nozzle of the associated valve.

SETTING OF THE TEST MODE

On the Burner Home screen, select any individual boiler/water heater which will guide to Burner Information screen.

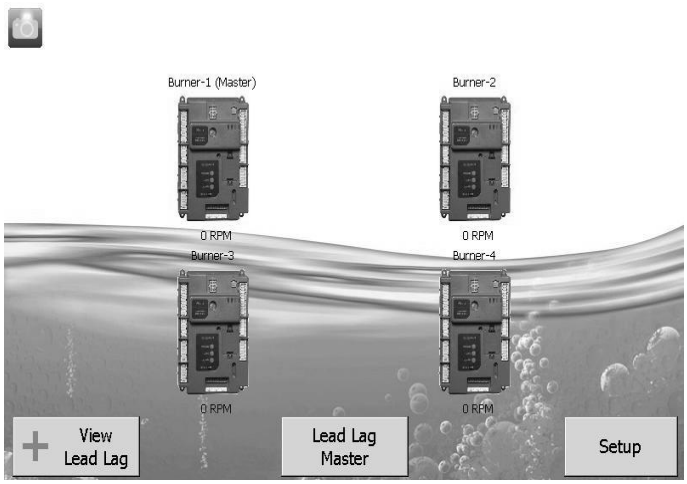


FIGURE 22. BURNER HOME SCREEN

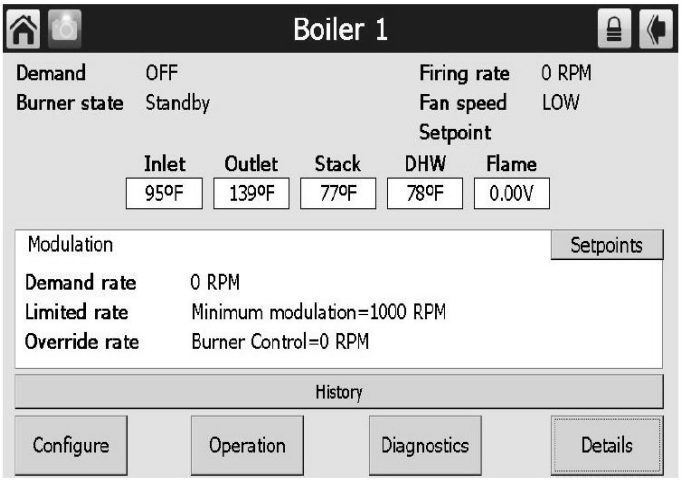


FIGURE 23. BURNER INFORMATION SCREEN

Click on Operation button, and under the Modulation Menu, set the required Firing rate (High/Low) by setting the RPM.

On the Firing Rate page, set the Firing rate RPM by selecting the Manual in Run check box.

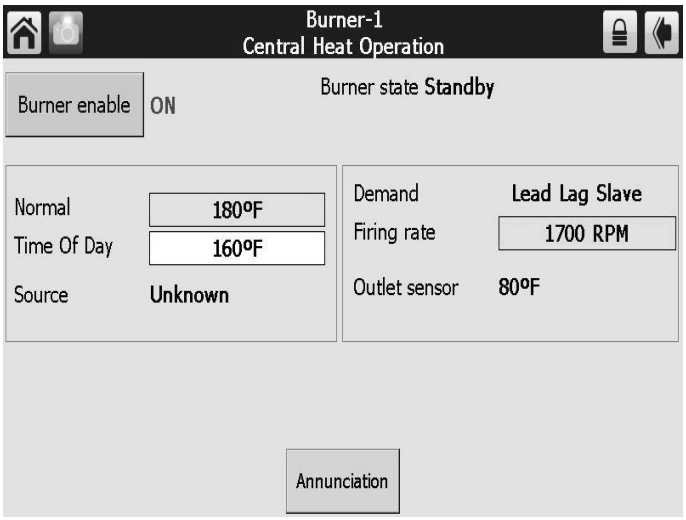


FIGURE 24. OPERATION SCREEN

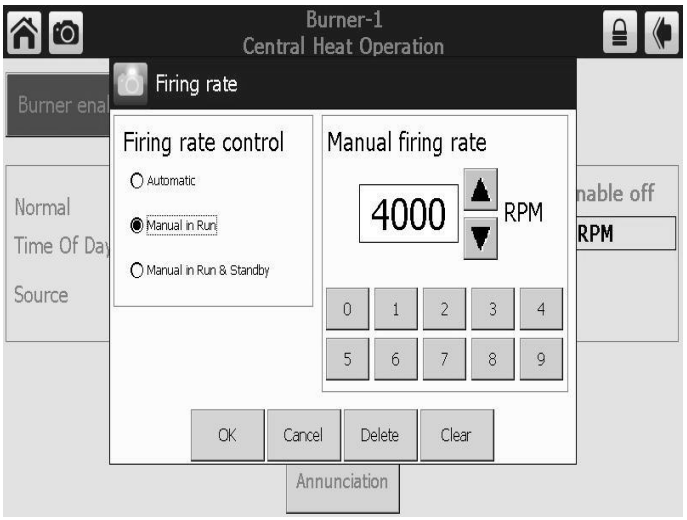


FIGURE 25. FIRING RATE PAGE

HIGH FIRING RATE SETTING

Set the boiler/water heater to the high firing rate by setting the High Firing Rate RPM as described below. Check combustion readings using a combustion analyzer. If combustion readings are not in accordance with the chart below adjust the gas valve as follows: remove the flat, round, blue plastic cap from the cover. For more information, refer to the Instruction Manual. Using a 3 mm (7/64") hex wrench, turn the adjustment screw counterclockwise to increase or clockwise to decrease gas flow and achieve the desired CO_2 level. Refer to the Table 7 for correct settings. There will be a slight time delay between the adjustment and the response of the CO_2 measuring instrument. Adjust the settings in small increments and allow the combustion readings to stabilize before readjusting. When desired adjustments are complete, reinstall the blue plastic cap on the cover. Combustion samples should be taken in the stack within two feet of the boiler/water heater. The carbon monoxide (CO) values in the combustion sample should not exceed 150 PPM under any circumstances. Contact OEM for any abnormal conditions leading to excessive CO above 150 PPM.

TABLE 7. HIGH FIRE RATE SETTING

MODELS (XB/XW)	RPM (APPROXIMATE FACTORY SET)		CO_2		*MANIFOLD PRESSURE INCHES W.C (KPA)	
	NATURAL GAS	PROPANE	NATURAL GAS	PROPANE	NATURAL GAS	PROPANE
1000	4450	4750	8.5 - 9.2%	9.3 - 10.2%	-3.5 (-0.87)	-4.7 (-1.17)
1300	4850	5100	8.5 - 9.2%	9.3 - 10.2%	-3.0 (-0.75)	-3.6 (-0.89)
1700	5700	5700	8.5 - 9.2%	9.3 - 10.2%	-3.6 (-0.89)	-4.4 (-1.09)
2000	4700	4750	8.5 - 9.2%	9.3 - 10.2%	-3.9 (0.97)	-4.9 (-1.22)
2600	5200	5100	8.5 - 9.2%	9.3 - 10.2%	-3.3 (-0.82)	-3.6 (-0.89)
3400	5700	5700	8.5 - 9.2%	9.3 - 10.2%	-3.5 (-0.87)	-4.4 (-1.09)

LOW FIRING RATE SETTING

Set the boiler/water heater to the low firing rate by setting the Low Firing Rate RPM as described below. Check combustion readings using a combustion analyzer. If combustion readings are not in accordance with the chart shown below adjust as follows: remove the cap on the gas regulator using a slotted screwdriver. For more information, refer to the Instruction Manual. This will expose the offset adjustment screw. Using a TORX® T40 or a 5 mm hex wrench, carefully adjust the low fire gas setting to achieve the CO_2 level prescribed in Table 8.

Adjustments to the offset pressure regulators should not exceed 1/4 turn at a time before allowing the readings to respond and stabilize.

After proper low fire offset adjustment is made, reinstall the slotted cap on the regulator.

Following all gas valve adjustments, check for proper light-off and verify correct fuel/air mix and combustion quality throughout the entire firing range (from lowest to highest fan speed).

Note: The rotation of the Low Fire adjustment is opposite of the High Fire as follows: Clockwise rotation increases gas flow, counterclockwise rotation decreases gas flow. Make sure the Manual Mode is set back to Automatic Mode to each of the burners, once the required settings are done. Turn off the individual burner before proceeding to the next burner settings. Depending on the boiler/water heater size and capacity, the flame voltage will be between 10-15 volts for low fire and 25-32 volts for high fire settings. Check for gas valve settings and combustion for varied voltage levels.

TABLE 8. LOW FIRE RATE SETTING

MODELS (XB/XW)	RPM (APPROXIMATE FACTORY SET)		CO_2		*MANIFOLD PRESSURE INCHES W.C (KPA)	
	NATURAL GAS	PROPANE	NATURAL GAS	PROPANE	NATURAL GAS	PROPANE
1000	1650	1540	7.3 - 8.2%	8.4 - 8.8%	-0.3 (-0.07)	-0.25 (-0.06)
1300	1650	1600	7.3 - 8.2%	8.4 - 8.8%	-0.2 (-0.05)	-0.14 (-0.03)
1700	1700	1700	7.3 - 8.2%	8.4 - 8.8%	-0.2 (-0.05)	-0.23 (-0.05)
2000	1550	1540	7.3 - 8.2%	8.4 - 8.8%	-0.3 (-0.07)	-0.31 (-0.07)
2600	1700	1600	7.3 - 8.2%	8.4 - 8.8%	-0.2 (-0.05)	-0.14 (-0.03)
3400	1700	1700	7.3 - 8.2%	8.4 - 8.8%	-0.2 (-0.05)	-0.23 (-0.05)

*** NOTE: Values listed in Table 7 and Table 8 are tested under laboratory conditions with minimum vent length. Values may slightly vary depending on ambient conditions and field equipment accuracy.**

TURNING THE BOILER/WATER HEATER OFF

NEVER TURN OFF POWER TO THE BOILER/WATER HEATER WHILE IT IS FIRING unless an emergency shut down is required. Repeated sudden stops while firing can damage the boiler/water heater. To shut down the boiler/water heater safely do one of the following so the boiler/water heater can go through a normal shut down sequence with post purge cycles that cool down the Heat Exchanger and purge the combustion chamber:

- Lower the Operating Set Point to it's lowest setting.
- Lower the set point of the external Primary System Control in use to it's lowest setting.
- Then turn the boiler/water heater off using the Lead Lag Master switch on the display.

CONTROL SYSTEM OPERATIONS

BURNER CONTROL SYSTEM

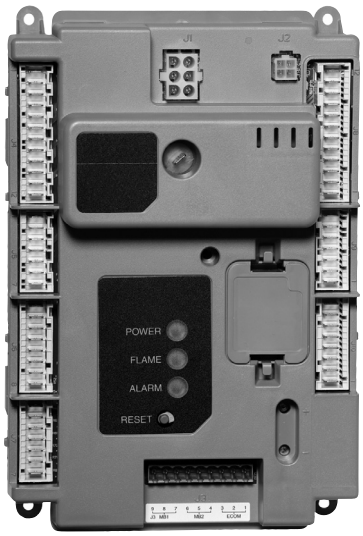


FIGURE 26. R7910A1138 CONTROL SYSTEM

The R7910A1138 is a burner control system that provide heat control, flame supervision, circulation pump control, fan control, boiler/water heater control sequencing, and electric ignition function. It will also provide boiler/water heater status and error reporting. Multiple boiler/water heaters can be joined together to heat a system instead of a single, larger burner or boiler/water heater. Using boiler/water heaters in parallel is more efficient, costs less, reduces emissions, improves load control, and is more flexible than the traditional large boiler/water heater.

Control System consists of:

- R7910A1138 Control Device.
- S7999D Touchscreen Display—required for setup and ModBus communication but not required for the system to operate once the R7910A1138 is programmed.
- S7910A Local Keyboard Display Module.
- Flame Sensor.
- Temperature Sensor, NTC Type 10KΩ at 77°F (25°C) or 12KΩ at 77°F (25°C).
- Limit Sensor, NTC Type 10KΩ at 77°F (25°C).
- 24V Digital I/O.

OVERVIEW

Functions provided by the R7910A1138 include automatic boiler/water heater sequencing, flame supervision, system status indication, firing rate control, load control, CH/DHW control, limit control, system or self-diagnostics and troubleshooting.

The R7910 maximum version of the controller offers:

1. NTC-temperature sensor for:
   - Outlet Limit And Temperature.
   - Stack Temperature Limit and Temperature.
   - Inlet Temperature.
   - Outdoor Temperature (R7910 only).
2. Modulating output PWM-driven rotation speed controlled DC-fan for optimal modulation control.
3. Three Pump Outputs with 5 selectable operation modes.
4. 24VAC:
   - Output control of gas valve (Pilot and Main) and External Ignition Transformer.
   - Digital inputs for room limit control, high limit control, Gas pressure switch, low water cutoff.
5. External spark transformer.
6. Flame sensor.
7. Test jacks for flame signal measurement from a flame sensor.
8. Alarm Output.

COMMUNICATIONS AND DISPLAYS

Two modes of communications are available to the R7910.

1. The R7910 has two RS485 communication ports for ModBus that allows for interfacing to one or all R7910s of a system and presents them individually to the user. The S7999D System Operator interface is a color touchscreen display used for configuration and monitoring of the R7910A. Though configuration can be done through the display, it is not recommended as all the parameters are pre-configured by the manufacturer. Any custom configuration required by the field should be done in consultation with the A. O. Smith qualified service technician. Control Operation and display status in both test and graphical modes can be shown along with the ability to setup. The R7910 can also be remotely reset through the S7999D display.
2. Either ModBus RS485 communication port can be used to allow configuration and status data to be read and written to the R7910. Support a Master S7999D or a Building Automation master to control the R7910 to respond to a single ModBus address to service the requests of the ModBus master in a Lead/Lag arrangement.

SPECIFICATIONS

1. Electrical Ratings:

Operating voltage

- 24VAC (20 to 30 VAC, 60 Hz ±5%)
- 30 amps (Single Heat Exchanger)
- 60 amps (Double Heat Exchanger)

Connected Load for Valve and annunciator functions:

- 24VAC, 60Hz
- 120VAC (+10%/-15%), 60Hz (±5%)
- Model Specific

2. Corrosion:
   - R7910A must not be used in a corrosive environment.
3. Operating Temperature: -4°F to 150°F (-20°C to 66°C)
4. Storage/Shipping Temperature: -40°F to 150°F (-40°C to 66°C).
5. Humidity:
   - Up to 95% Relative Humidity, noncondensing at 104°F for 14 days. Condensing moisture may cause safety shutdown.
6. Vibration: 0.0 to 0.5g Continuous (V2 level)
7. Enclosure: Nema 1/IP40.
8. Approvals:

Underwriters Laboratories, Inc. (UL): Component Recognized: File No. MP268 (MCCZ)

- R7910 is certified as UL372 Primary Safety Controls.
- The R7910 is certified as UL353 Limit Rated device when using part number 50001464 dual element limit rated NTC sensors.

CSD-1 Acceptable.

Meets CSD-1 section CF-300 requirements as a Primary Safety Control.

Meets CSD-1 section CW-400 requirements as a Temperature Operation control.

Meets CSD-1 section CW-400 requirements as a Temperature High Limit Control when configured for use with 10 kohm NTC sensors.

Federal Communications Commission, Part 15,

Class B. Emissionss.

BURNER CONTROL OPERATION

Safety Shutdown of Burner Control Functions

Safety Shutdown (Lockout) occurs if any of the following occur during the indicated period:

1. INITIATE PERIOD:

a. A/C line power errors occurred.
b. Four minute INITIATE period has been exceeded.

2. STANDBY PERIOD:

a. Flame signal is present after 240 seconds.
b. Main Valve Terminal is energized.
c. Internal system fault occurred.

3. PREPURGE PERIOD:

a. Flame signal is detected for 10 seconds accumulated time during PREPURGE.
b. Purge Rate Fan RPM or High Fire Switch fails to close within four minutes and fifteen seconds after the firing rate motor is commanded to drive to the high fire position at the start of PREPURGE.
c. Light off Rate Fan RPM or Low Fire Switch fails to close within four minutes and fifteen seconds after the firing rate motor is commanded to drive to the low fire position at the end of PREPURGE.
d. Lockout Interlock (if programmed) does not close within 10 seconds.
e. Lockout Interlock opens during PREPURGE.
f. Main Valve terminal is energized.
g. Internal system fault occurred.

4. PRE-IGNITION TIME:

a. Lockout Interlock opens.
b. IAS Purge and Ignition enabled and the Interlock opens.
c. Preignition Interlock opens.
d. Pilot Valve terminal is energized.
e. Main Valve terminal is energized.

5. PILOT FLAME ESTABLISHING PERIOD. (PFEP):

a. Lockout Interlock opens (if enabled).
b. Pilot Valve terminal is not energized.
c. No flame is present at the end of the PFEP, or after programmed number of retry attempts.
d. Main valve terminal is energized.
e. Internal system fault occurred.

6. MAIN FLAME ESTABLISHING PERIOD. (MFEP):

a. Lockout Interlock opens (if enabled).
b. Pilot valve terminal is not energized.
c. Main valve terminal is not energized.
d. No flame present at the end of MFEP.
e. Internal system fault occurred.

7. RUN PERIOD:

a. No flame is present, or flame is lost (if enabled-lockout).
b. Lockout Interlock opens) if enabled).
c. IAS Purge and Ignition enabled and the Interlock opens.
d. Pilot terminal energized (if programmed as Interrupted Pilot).
e. Main valve terminal is not energized.
f. Internal system fault occurred.

8. POSTPURGE PERIOD:

a. Preignition Interlock does not close in five seconds.
b. Pilot Valve terminal is energized.
c. Main Valve terminal is energized.
d. Internal system fault occurred.
e. Flame sensed 240 seconds accumulated time after the RUN period.

Safety Shutdown:

1. If the lockout interlocks open or a sensor designated as a safety limit are read as defective, Control System will lockout and the blower motor will be de-energized.

If these open during the firing period, all fuel valves will be de-energized, the system will complete postpurge, and will lockout indicated by an alarm.

2. If the main flame is not detected at the end of the last recycle attempt of the main flame establishing period, all fuel valves will be de-energized, the device will complete postpurge, and will lockout indicated by an alarm.
3. If the flame sensing signal is lost during the run period (if lockout is selected), all fuel valves will be de-energized within 4 seconds after the loss of the flame signal, the device will complete postpurge, and will lockout indicate by an alarm.
4. Manual reset is required following any safety shutdown. Manual reset may be accomplished by pressing the push button on the device, pressing the remote reset wired into connector J10, or through an attached display.

Interrupting power to Control System will cause electrical resets, but does not reset a lockout condition.

GENERAL OPERATIONAL SEQUENCE

Initiate

The R7910 enters the Initiate sequence on Initial Power up or:

- Voltage fluctuations vary less than 20VAC or greater than 30VAC.
- Frequency fluctuations vary +/-5% (57 to 63 Hz).
- If Demand, LCI, or Stat interrupt (open) during the Prepurge Period.
- After the reset button is pressed or fault is cleared at the displays.

The Initiate sequence also delays the burner motor from being energized and de-energized from an intermittent AC line input or control input.

If an AC problem exists for more than 240 seconds a lockout will occur.

Hydronic/Central Heating (XB Boilers)

Start-up sequence central heating request (system in standby):

1. Heat request detected (On Setpoint - On Hysteresis).
2. The CH pump is switched on.
3. After a system Safe Start Check, the Blower (fan) is switched on after a dynamic ILK switch test (if enabled).
4. After the ILK switch is closed and the purge rate proving fan RPM is achieved (or High Fire Switch is closed) - prepurge time is started.
5. When the purge time is complete, the purge fan RPM is changed to the Lightoff Rate or if used, the damper motor is driven to the Low Fire Position.
6. As soon as the fan-rpm is equal to the light-off rpm (or the Low Fire Switch closes), the Trial for Ignition or Pre-Ignition Time is started.
7. Pre-Ignition Time will energize the ignitor and check for flame.
8. Trial for Ignition. Specifics for timings and device actions are defined by A. O. Smith.
9. The ignition and the gas valve are switched on.
10. The ignition is turned off at the end of the direct burner ignition period, or for a system that does use a pilot, at the end (or optionally at the middle) of the Pilot Flame Establishing Period (PFEP). For an interrupted pilot system this is followed by a Main Flame Establishing Period (MFEP) where the pilot ignites the main burner. For an intermittent pilot there is no MFEP.
11. The fan is kept at the lightoff rate during the stabilization timer, if any.
12. Before the release to modulation, the fan is switched to minimum RPM for the CH Forced Rate and Slow Start Enable, if the water is colder than the threshold.
13. At the end of the CH-heat request the burner is switched off and the fan stays on until post purge is complete.
14. A new CH-request is blocked for the forced off time set by the Anti Short Cycle (if enabled).
15. The pump stays on during the pump overrun time.
16. At the end of the pump overrun time the pump will be switched off.

Domestic Hot Water

Start-up sequence DHW-request (system in standby):

1. Heat request detected (Tank Sensor below Setpoint).
2. The pump is switched on.
3. After a system Safe Start Check, the Blower (fan) is switched on after a dynamic ILK switch test (if enabled).
4. After the ILK switch is closed and the purge rate proving fan RPM is achieved (or High Fire Switch is closed) - prepurge time is started.
5. When the purge time is complete, the purge fan RPM is changed to the Lightoff Rate or if used, the damper motor is driven to the Low Fire Position.
6. As soon as the fan-rpm is equal to the light-off rpm (or the Low Fire Switch closes), the Trial for Ignition or Pre-Ignition Time is started (depending on configuration).
7. Pre-Ignition Time will energize the ignitor and check for flame.
8. Trial for Ignition. Specifics for timings and device actions are defined by the OEM or installer.
9. The ignition and the gas valve are switched on.
10. The ignition is turned off at the end of the direct burner ignition period, or for a system that does use a pilot, at the end (or optionally at the middle) of the Pilot Flame Establishing Period (PFEP). For an interrupted pilot system this is followed by a Main Flame Establishing Period (MFEP) where the pilot ignites the main burner. For an intermittent pilot there is no MFEP.
11. The fan is kept at the lightoff rate during the stabilization timer, if any.
12. Before the release to modulation, the fan is switched to minimum RPM for the DHW Forced Rate and Slow Start Enable, if the water is colder than the threshold.
13. At the end of the DHW-heat request the burner is switched off and the fan stays on until post purge is complete.
14. The pump stays on during the pump overrun time.
15. At the end of the pump overrun time the pump will be switched off.

LEAD LAG

Burner Control System devices contain the ability to be a stand-alone control, operate as a Lead Lag Master control (which also uses the Burner Control System function as one of the slaves), or to operate solely as a slave to the lead lag system.

Burner Control System devices utilize two ModBus™ ports (MB1 and MB2) for communications. One port is designated to support a system S7999D display and the other port supports communications from the LL Master with its slaves.

The Lead Lag master is a software service that is hosted by a Burner Control System. It is not a part of that control, but is an entity that is “above” all of the individual Burner Controls (including the one that hosts it). The Lead Lag master sees the controls as a set of Modbus devices, each having certain registers, and in this regard it is entirely a communications bus device, talking to the slave Buner Control Systems via Modbus.

The LL master uses a few of the host Burner Control System's sensors (header temperature and outdoor temperature) and also the STAT electrical inputs in a configurable way, to provide control information.

LEAD LAG (LL) MASTER GENERAL OPERATION

The XP product is a multiple burner application and it works on the basis of the Lead Lag Operation. The XB Boiler is factory configured for Hydronic/Central Heating application, whereas the XWH Water Heater is factory configured for Domestic Hot Water application. The LL master coordinates the firing of its slave Burner Control Systems. To do this it adds and drops stages to meet changes in load, and it sends firing rate commands to those that are firing.

The LL master turns the first stage on and eventually turns the last stage off using the same criteria as for any modulation control loop:

- When the operating point reaches the Setpoint minus the On hysteresis, then the first Burner Control System is turned on.
- When the operating point reaches the Setpoint plus the Off hysteresis then the last slave Burner Control (or all slave Burner Controls) are turned off.

The LL master PID operates using a percent rate: 0% is a request for no heat at all, and 100% means firing at the maximum modulation rate.

This firing rate is sent to the slaves as a percentage, but this is apportioned to the slave Burner Controls according to the rate allocation algorithm selected by the Rate allocation method parameter.

For some algorithms, this rate might be common to all slave Burner Controls that are firing. For others it might represent the total system capacity and be allocated proportionally.

For example, if there are 4 slaves and the LL master's percent rate is 30%, then it might satisfy this by firing all four slaves at 30%, or by operating the first slave at 80% (20% of the system’s capacity) and a second slave at 40% (10% of the system’s capacity).

The LL master may be aware of slave Burner Control's minimum firing rate and use this information for some of its algorithms, but when apportioning rate it may also assign rates that are less than this. In fact, the add-stage and drop-stage algorithms may assume this and be defined in terms of theoretical rates that are possibly lower than the actual minimum rate of the Burner Control. A Burner Control that is firing and is being commanded to fire at less than its minimum modulation rate will operate at its minimum rate: this is a standard behavior for a Burner Control in stand-alone (non-slave) mode.

If any slave under LL Master control is in a Run-Limited condition, then for some algorithms the LL master can apportion to that stage the rate that it is actually firing at. Additionally when a slave imposes its own Run-limited rate, this may trigger the LL Master to add a stage, if it needs more capacity, or drop a stage if the run-limiting is providing too much heat (for example if a stage is running at a higher-than commanded rate due to anti-condensation).

By adjusting the parameters in an extreme way it is possible to define add-stage and drop-stage conditions that overlap or even cross over each other. Certainly it is incorrect to do this, and it would take a very deliberate and non-accidental act to accomplish it. But there are two points in this:

1. LL master does not prevent it, and more important;
2. It will not confuse the LL master because it is implemented as a state machine that is in only one state at a time;

For example:

— If its add-stage action has been triggered, it will remain in this condition until either a stage has been added, or

— The criteria for its being in an add-stage condition is no longer met; only then will it take another look around to see what state it should go to next.

ASSUMPTIONS

Modulating stage The modulating stage is the Burner Control that is receiving varying firing rate requests to track the load.

First stage: This is the Burner Control System that was turned on first, when no slave Burner Controls were firing.

Previous stage: The Burner Control that was added to those stages that are firing just prior to the adding of the Burner Control that is under discussion.

Next stage: The Burner Control that will or might be added as the next Burner Control to fire.

Last stage: The Burner Control that is firing and that was added the most recently to the group of slaves that are firing. Typically this is also the modulating stage, however as the load decreases then the last-added stage will be at its minimum rate and the previous stage will be modulating.

Lead boiler/water heater: The Lead boiler/water heater is the Burner Control that is the first stage to fire among those stages which are in the equalize runtime (Lead/Lag) group. If a boiler/water heater is in the "Use first" group it may fire before the Lead boiler/water heater fires.

First boiler/water heater: A Burner Control may be assigned to any of three groups: "Use First", "Equalize Runtime", or "Use Last". If one or more Burner Controls are in the "Use First" category, then one of these (the one with the lowest sequence number) will always be the first boiler/water heater to fire. If there is no Buner Control System in the "Use First" category and one or more are in the "Equalize Runtime" category, then the First boiler/water heater is also the Lead boiler/water heater.

LOCAL OPERATOR INTERFACE: DISPLAY SYSTEM

FIGURE 27. S7999D DISPLAY SYSTEM

The S7999D is a microprocessor-based touchscreen Operator Interface (OI) display that provide an operator interface for monitoring and configuring parameters in the Burner Control system.

The S7999D is used to monitor an individual burner on the XB Boilers/XWH Water Heaters applications in a lead/lag arrangement. It consists of 2 RS485 ports (COM 1 & COM 2) and USB port. The S7999D display can be flush front or behind mounted into a panel cutout. Wiring connections to the S7999D are through a removable 8-pin wiring connector.

FEATURES

- Individual boiler/water heater status, configuration, history, and diagnostics.
- Allows configuration and monitoring of the Burner Control Controls burner control sequence, flame signal, diagnostics, historical files, and faults.
- S7999D OI Display only:
  - Allows switching view between multiple burners.
  - Allows viewing Lead-Lag Master.
  - Real-time data trending analysis and transferring saved trend data to Excel spreadsheet.
  - 7” 800 x 480, 24 bit high resolution color LCD touch screen for clarity.
  - Audio output with integral speaker for sound output.
  - Adjustable backlight control.
  - Real time clock with coin-cell battery back up (CR2032).
  - S7999D has Black Border.
  - Volume control.
  - Screen Capture function to capture screen images.
  - USB port for file transfers and software updates
  - 2 RS-485 (COM1 & 2) ports for Modbus™ interface to Burner controls and BAS Gateway.
  - Windows® CE 6.0 Operating System.
  - 8-pin connector, back-up battery and mounting hardware are provided.

SPECIFICATIONS

1. Electrical Ratings:
   - Input Voltage: 18 – 30 Vac (24Vac nominal), 50/60 Hz
   - Input Current: 500 mA max.
   - Power consumption: 12W max.
2. Operating Temperature: -4 to 158 ºF (-20 to 70 ºC)
3. Storage/Shipping Temperature: -22 to 176 ºF (-30 to 80 ºC)
4. Humidity: 90% RH, non-condensing.
5. Enclosure rating: IP10 / NEMA 1

6. Approvals:

FCC Part 15, Class A Digital Device

Underwriter's Laboratories, Inc. (UL) (cUL) Component Recognized (for non-continuous operation): File Number MH17367 (MJAT2, MJAT8).

INSTALLATION INSTRUCTIONS (S7999D OI DISPLAY)

Mounting the S7999D OI Display and Power Supply

The OI Display can be mounted on the door panel of an electrical enclosure.

1. Select the location on the door panel to mount the display; note that the device will extend into the enclosure at least one inch past the mounting surface.
2. Provide an opening in the panel door 8" wide X 5 1/2" high (for front panel mount) or 7 1/8" wide X 4 11/16" high (for rear panel mount).
3. Place the OI Display in the opening and use it as a template to mark the location of the four mounting screw holes. Remove the device.
4. Using pilot holes as guides, drill 1/4 in. holes through the door panel.
5. Place the display in the opening, aligning the mounting holes in the device with the drilled holes in the panel.
6. Secure the display to the panel with four #6-32 screws and nuts provided.
7. Wire the 24VAC power supply and the RS-485 cables.
8. Ensure the 8-pin connector plug is aligned with the header pins when inserting the 8-pin connector plug back onto the Display. Secure firmly.
9. Please make sure resistive spark cable is used with the display system, and route the wires away from the display as much as possible.

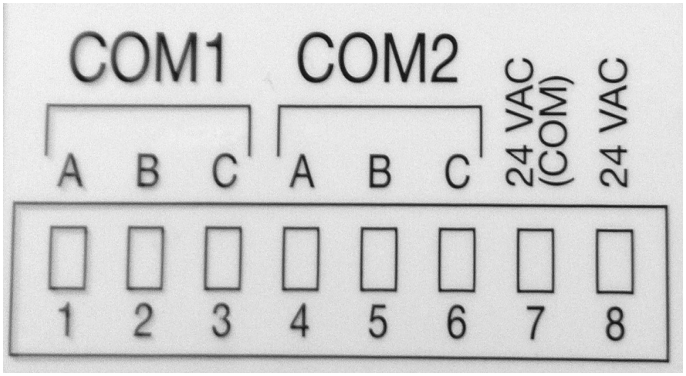


FIGURE 28. S7999D OI DISPLAY CONNECTOR TERMINALS

QUICK SETUP (S7999D OI DISPLAY)

1. Make sure the S7999D 8-pin connector is properly aligned and pressed firmly in place.
2. Make sure the wires between the 8-pin connector and the controller are properly wired and secure.

WARNING: Electrical Shock Hazard. It can cause severe injury, death or equipment damage. Line voltage is present at the 120 VAC power supply.

3. Make sure the power supply is connected securely to the 120 VAC power source.

STARTING UP THE S7999D OI DISPLAY

Power-up Validation

The Home page will appear when the device is properly powered. Select the Setup button to adjust the contrast and sound as desired.

If the screen is dim, check the pin 7 and 8 wiring connections.

A “camera” icon on the left top corner is for screen snapshot use. Up to 16 snapshots can be stored in the display and can be copied to a USB memory stick.

Note: An Advanced Startup screen displays for five seconds after power-up before the Home page displays. This screen allows the user to upgrade the software in the System Display and should normally be bypassed.

Three LEDs exist for I/O traffic: one for the Ethernet network port and two for Modbus™ ports. Modbus Com Port 2 is not active on this device.

1. Make sure the Power and COM1 LEDs are blinking.
2. If the LEDs are not blinking:
   - Make sure the proper connections have been made between the Modbus COM1 Port and the first controller device in the Modbus network.
   - Ensure proper wiring of the OI Display 9-pin Header Connections.
3. If connected to a BAS application, COM2 LED will blink indicating BAS traffic.

HOME PAGE (S7999D OI DISPLAY)

Make sure a screen similar to Figure 29 appears after the OI Display has completely powered up.

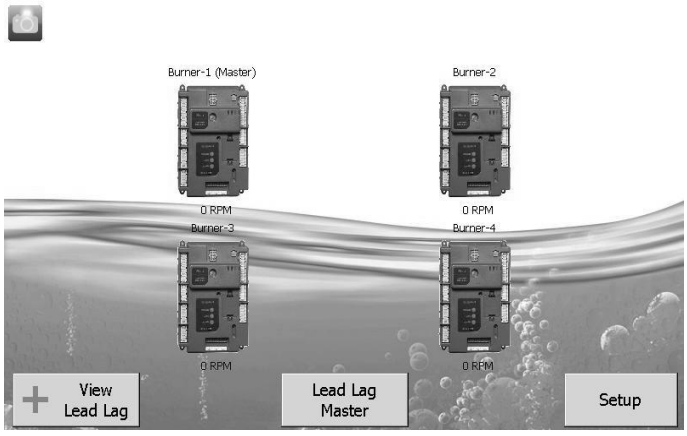


FIGURE 29. S7999D HOME PAGE (BOILER/WATER HEATER 1 IN NORMAL OPERATION)

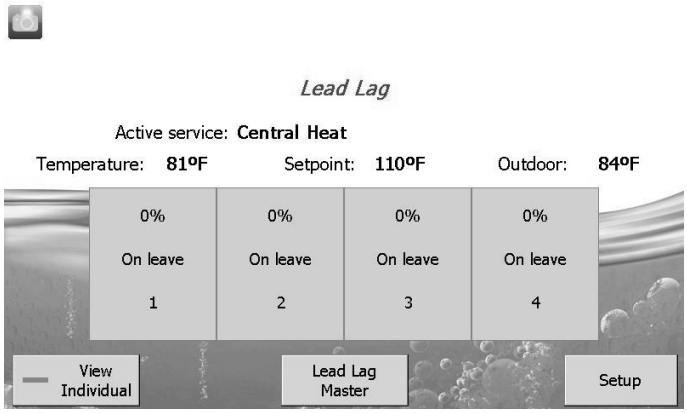


FIGURE 30. S7999D LEAD LAG HOME PAGE

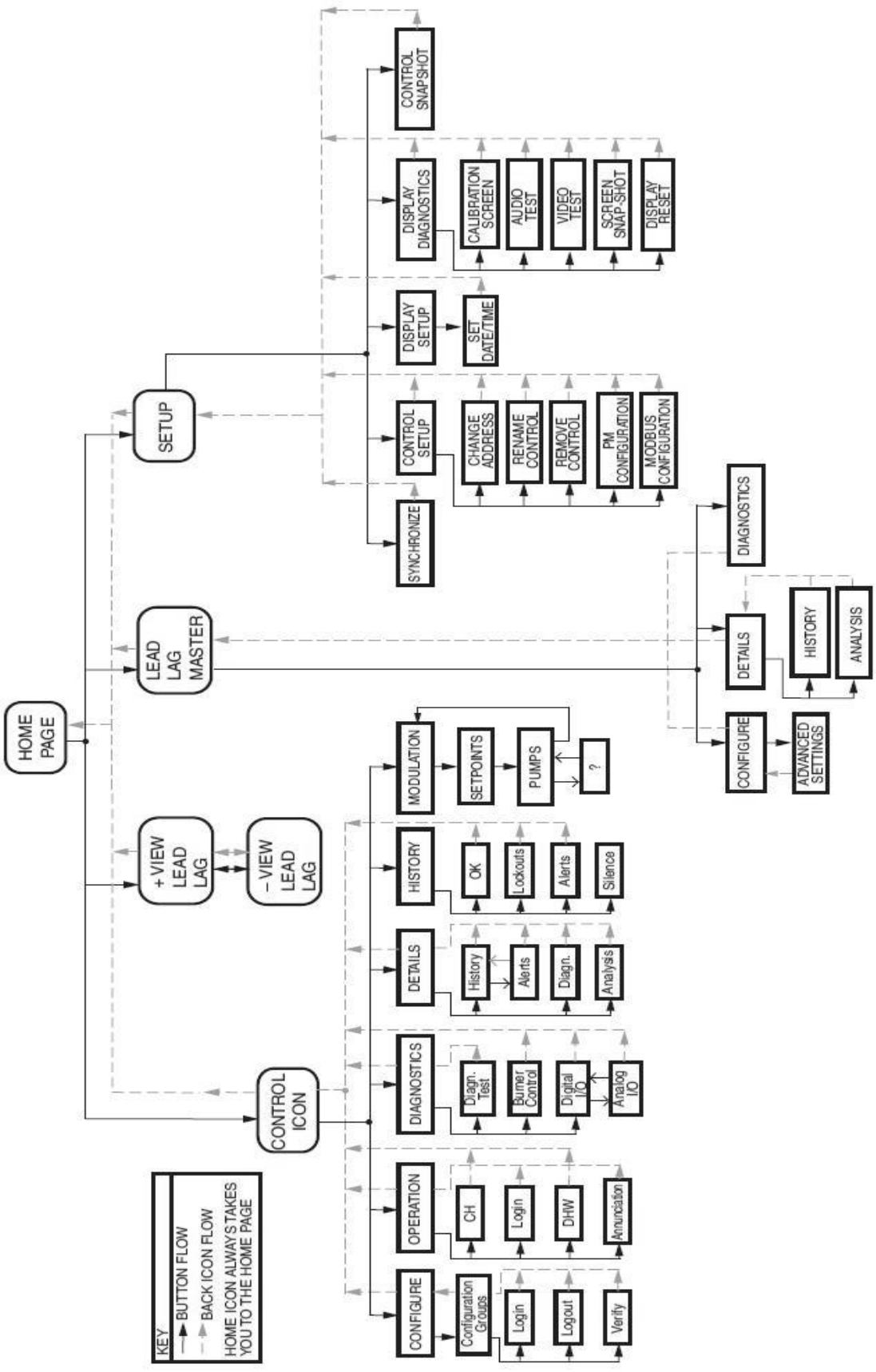


FIGURE 31. S7999D DISPLAY PAGE FLOW

On System applications, each Burner Control is represented on the Home page by an icon and name. Pressing the icon allows the user to zoom in on that burner and see its specific details. These details are provided on a new page, which can include additional buttons that display additional detail and operation information, which itself leads to other pages. The pages are traversed in a tree structure method, as shown in Figure 31 on Page 47.

The Control System icons will appear in one of four colors indicating the boiler/water heater status.

- Blue: Normal operation
- Red: Lockout condition
- Gray: Communication error (disconnected or powered off)
- Yellow: Holding mode

Up to 8 Systems can be displayed on the Home page. The name of each burner is displayed next to the Control System icon button. When Lead Lag is enabled, the system header temperature and firing rate are displayed for each System. When the burner is in standby or not firing the firing rate is not displayed.

Note: The boiler/water heater name may be cut off on the Home page when all icons are present.

The Home page also includes buttons for Lead Lag configuration when lead lag master and slave in the Burner control is enabled. Pressing the Setup button on the Home page displays miscellaneous setup and diagnostic functions. It also contains the setup configuration for BAS applications.

The “Control snapshot” button allows the user to dump the current status and/or configuration settings of any Burner controller into a text document. The text document can be viewed on the display, saved to flash for later viewing, and can be written to a USB stick for viewing on a PC or file transfer. Pressing the Burner control icon opens that control’s status page. Go to “Configure” button to continue.

PAGE NAVIGATION

The Burner Control OI Displays present information and options in a paged manner. Pages are displayed in a tree structure in which the user navigates up and down to arrive at the desired Function. The page descriptions are provided below so that you can understand the purpose of each and view the selections, parameters, and information that is available or required on each.

COMMON OI DISPLAY PAGE SYMBOLS

Most pages have a Home button in the top-left corner of the screen and a Back button in the top-right corner of the screen. The Home button returns the user to the Home page and terminates any operation in progress. The Back button returns the user to the previous page.

Two other icons may be noticed near the boiler/water heater name.

A camera button is for screen snapshot use. Up to 16 snapshots can be stored in the display and can be copied to a USB memory stick.

A padlock indicates the operator is not currently logged in (may have been timed out) and a password is needed to change the setting. An unlocked padlock indicates the password has been entered and the operator has logged into system successfully.

STATUS OR HOME PAGE

A status (summary) page (Figure 32 on Page 49) is displayed when the S7999D display is connected. This status page appears on the S7999D when the Burner Control icon is pressed on the “Home” page. The status page displays the current condition of the burner control and displays some of the more important configuration settings.

The initial status page displayed contains summary status information as shown in Figure 32 on Page 49. Any status information not applicable for the installation is grayed/blanked out on the screen.

Buttons on this screen include:

- **Configure:** used to configure the burner control (password protected and all pre-configured).
- **Operation:** used to perform daily or frequent functions with the burner control, such as setpoint adjustment, etc.
- **Diagnostic:** used to view burner control diagnostic information (for servicing and temperature setting purpose only).
- **Details:** used to view burner control detail status information.
- **History:** used to view burner control history.
- **Pump:** used to expand the pump status information.
- **Modulation:** used to toggle between status displays: pump, setpoints, and modulation.

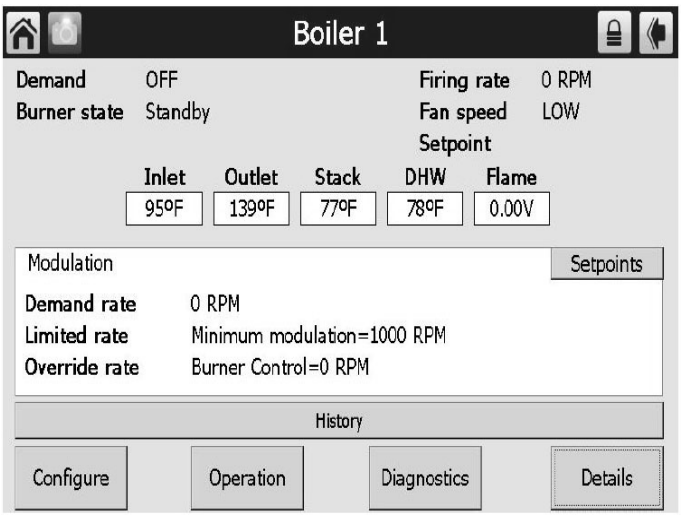


FIGURE 32. SUMMARY STATUS PAGE (HYDRONIC CONTROL)

CONFIGURE BUTTON

The configuration page allows the user to view and set parameters that define how the connected Burner Control System R7910A functions.

The configuration page allows the user to view and set parameters that define how the connected R7910A functions in the hydronic heating system. All parameters are factory configured and only a qualified service technician must perform the configuration settings).

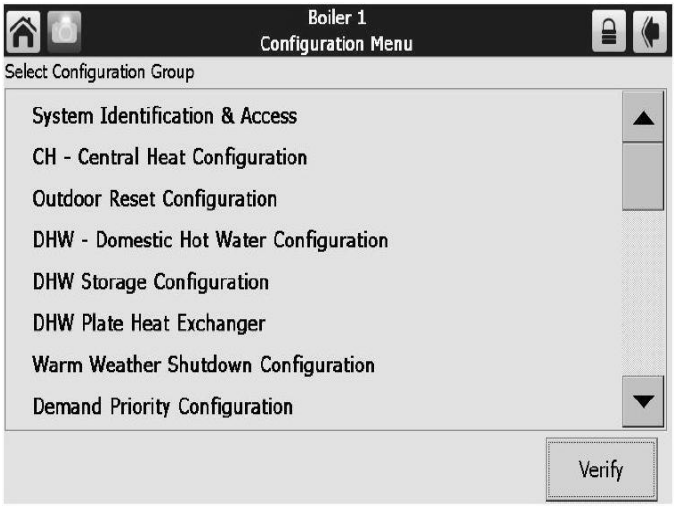


FIGURE 33. CONFIGURATION MENU PAGE

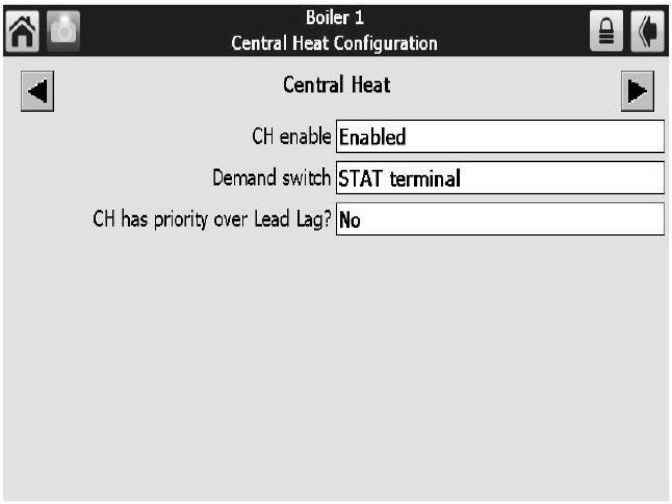


FIGURE 34. SAMPLE CONFIGURATION PAGE

CONFIGURATION PASSWORD

Some parameters require a valid configuration password be entered by the user before the parameter can be changed. The password need only be entered once while the user remains on the configuration pages and stays active. The display times out after 10 minutes of inactivity. User will have to login again if another secure parameter needs to be changed by pressing the Padlock button.

Three levels of access to Burner Control parameters are permitted. Each access level has defined rights when interfacing with configuration and status parameters within the controls.

- **End user:** The end user can read or view the control parameters and be allowed to change some operating parameters, CH setpoint as an example. (The end user does not need password).
- **Installer:** The installer can read all control parameters and change default allowed parameters. This access level is used to customize the control for a particular installation.
- **OEM:** The OEM can read and change all parameters, change sensor limits and burner control safety parameters.

Different passwords exist in the Burner Control for each access level. The end user level requires no password, but the installer and OEM levels have unique passwords defined for them.

The installer and OEM passwords can be changed in the Burner Control after logging in with the current password. When the password is changed, it is saved for all future logins.

Note: For the S7999D System OI display, each boiler/water heater in a multi-boiler/water heater configuration has its own set of installer and OEM passwords. To avoid user confusion, the passwords should be changed to the same password in each control, but there is no requirement to do so. Make sure to record your password.

The user is notified that a new password is needed to change a parameter (or until a password is entered successfully)—see Figure 35. The user can continue viewing the configuration parameters regardless of whether a password is entered successfully.

The Burner Controls maintain a password time-out that limits the scope of the password entry. Once a password is successfully entered, the control starts an internal timer that expires after 10 minutes of inactivity. After the timer expires, the user is required to re-enter a password before a parameter can be changed.

The user is not required to enter a configuration password for a parameter that has a lower access level than the access level achieved by an earlier password entry for any configuration group (as long as the user stays in the configuration pages). The user only needs to enter a password once until a parameter that has a higher access level is selected.

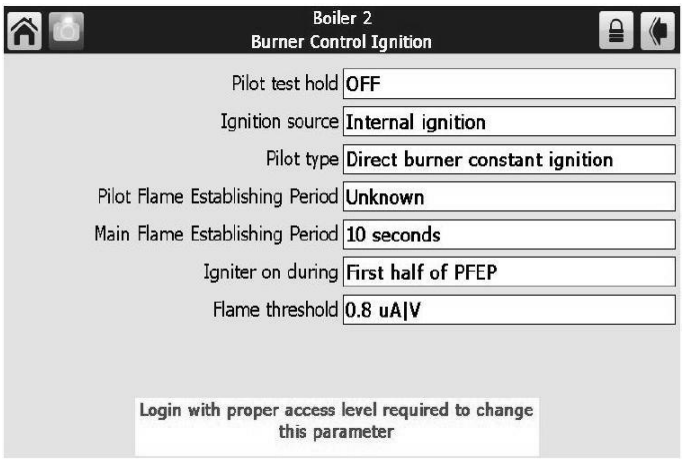


FIGURE 35. LOGIN REQUIRED

KEYBOARD

Some pages request user entry of characters. When this type of input is required, a keyboard page appears, as shown in Figure 36 on Page 51. The text box at the top of the screen displays the current (or default) setting of the user input. The user can add to this text, clear it, or change it.

The Shift key on the left side of the screen shifts between upper and lowercase characters. Pressing the Shift key toggles the keyboard from one mode to the other (continuous pressing of the Shift button is not required). The OK button should be pressed when the user is done entering the text input. The Cancel button on the bottom of the screen allows the user to ignore any text changes that have been made and keep the original text value. Pressing the OK or Cancel buttons returns the user to the page displayed prior to the keyboard page.

LOGIN

Pressing the Login button allows entering the password from a keyboard as shown in Figure 36. After the password is entered, the OK button is selected. The Cancel button aborts the password login.

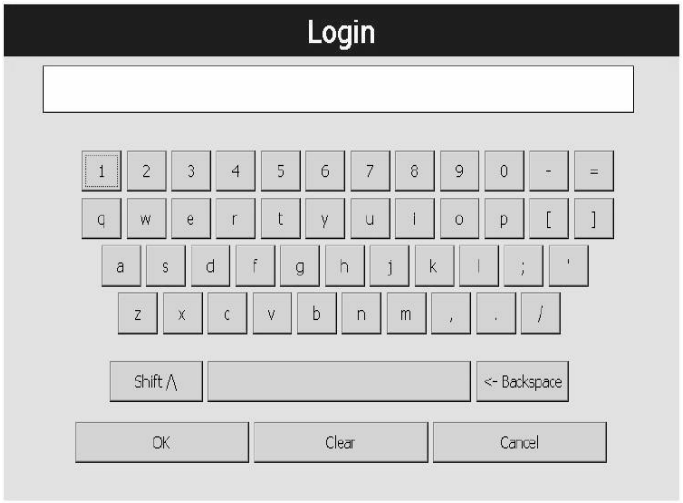


FIGURE 36. DEVICE LOGIN SCREEN

WARNING: Explosion Hazard. Improper configuration can cause fuel buildup and explosion. Improper user operation may result in property loss, physical injury or death.

Using the OI Displays to change parameters must be attempted by only experienced and/or licensed burner/boiler/water heater operators and mechanics.

CHANGE PARAMETER SETTINGS

Change parameter settings by selecting the parameter on the page. A dialog box displays for the parameter with controls allowing the user to change the value (see Figure 37). After changing the setting to a new value, press the OK button. Pressing the Cancel button leaves the parameter unchanged. The changed setting is reflected on the screen and sent to the control when the OK button is pressed.

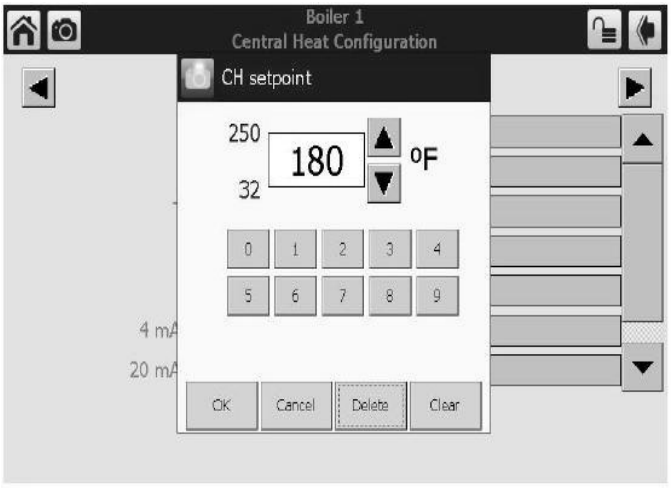


FIGURE 37. EXAMPLE OF CHANGE CONFIGURATION PARAMETER PAGE

VERIFY

Pressing the Verify button displays safety configuration parameters for an additional verification step to commit the changes.

Safety parameters are grouped into blocks that include only safety parameters, not a mixture of safety data and non-safety data. All parameters within the safety group undergo a verification process. A safety parameter group is identified on the display to indicate when the configuration parameters are safety-related. Each safety parameter group is verified one at a time until all have been verified. See Figure 38 on Page 52.

Like operating parameters, safety parameters can be viewed without the need to enter a password.

Safety parameter blocks that have been changed require verification. The verification steps do not have to be completed immediately; the installer can move between and change parameter groups before the verification is done. A Verify button is enabled that allows the installer to conduct verification sessions (the example of the Verify button in Figure 33 on Page 49 is not yet enabled because the installer hasn't logged in).

FIGURE 38. SAFETY VERIFICATION

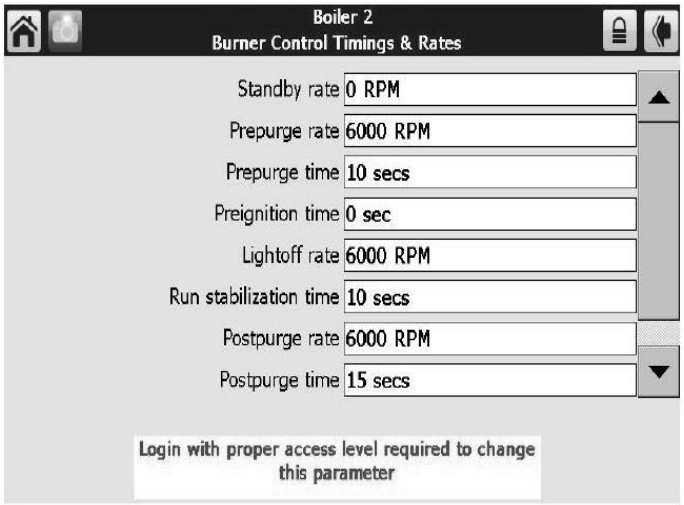


FIGURE 39. EDIT SAFETY DATA

NOTE: When the installer proceeds with the safety parameter configuration, the control unlocks the safety parameters in this group and marks them unusable. Failure to complete the entire safety configuration procedure leaves the control in an un-runnable state (lockout 2).

All safety configuration parameters in the group should have the same access level. If this condition isn't so, the user is asked to enter another password when a higher access level is needed.

Successful login is noted by the lock icon, which changes to "unlocked" on the page. The installer may begin to change safety parameters (or any other parameters) at that time (see Figure 39). If the Burner Control is in an unconfigured (or new) state, then this warning doesn't appear. All parameters that need changes should be changed during the login.

If the safety configuration session is terminated after it has started (in the Edit or Verify stages), the Burner Control is left in an unconfigured (unrunnable) state.

The installer can terminate the session by pressing the Menu button or by attempting to leave the Verification page with the Home or Back buttons (top-left and top-right screen corners, respectively). However, leaving the session at this point leaves the control in an unrunnable state and confirms whether the installer still wants to do so.

The settings of all parameters in each safety block must be verified to save them in the control.

When the installer is done changing safety parameters, pressing the Verify button on the configuration screen begins the Verification process. The settings for all safety parameters in each changed block are presented and Verified by the installer (see Figure 40).

FIGURE 40. SAFETY PARAMETER CONFIRMATION

FIGURE 41. SAFETY PARAMETER RESET

Press the Yes button to confirm each safety parameter block. If the No button is selected, the safety parameter block remains unconfirmed and the Configuration menu page is displayed. The control remains in an unconfigured state in this case.

After all safety parameter blocks have been confirmed, the installer is asked to press and hold the Reset button on the Burner Control to complete the safety verification session (see Figure 41).

When the Reset button is pressed and held for 3 seconds the confirmed safety parameters are saved in the control. The above Reset dialog box automatically closes when this step is completed. If this step is not performed, the control remains in a safety lockout state until the installer resolves the unverified safety parameters.

FAULT/ALARM HANDLING

Each Burner Control reports to the OI display when a safety lockout or an Alert occurs.

Safety lockouts are indicated on each configuration page as an alarm bell symbol. At the status page (for S7999D), the History button turns red. If the S7999D is displaying the system status icons, the control in alarm will turn red.

The lockout history can be displayed by pressing on the History button. The state information about each lockout is displayed along with the date/time that the lockout occurred (refer to Table 9). Current date/time stamp is a display setup feature.

NOTE: In the event of a power interruption, the date/time must be reset. The OI Display does NOT have a backup means.

TABLE 9. BURNER CONTROL LOCKOUT HISTORY

DATA	COMMENT
Lockout time	Set by display.
Fault Code	Unique code defining which lockout occurred.
Annunciator first out	First interlock in limit string results in a shutdown.
Description	Fault description.
Burner Lockout/Hold	Source/reason for lockout/ hold.
Burner control state	
Sequence time	Burner control state timer at time of fault.
Cycle	Burner control cycle.
Run Hours	Burner control hours.
I/O	All digital I/O status at time of fault.
Annunciator 1-8 states	All annunciator I/O status at time of fault.
Fault data	Fault dependent data.

An alert log can be displayed for each control by pressing the Alert button on the bottom of the history status page. A description of the alert is displayed along with the time when the alert occurred (refer to Table 10).

TABLE 10. BURNER CONTROL ALERT LOG

DATA	COMMENT
Alert Line	Set by display.
Alert Code	Unique Code defining which fault occured.
Description	Alert description.

HISTORY BUTTON

The History button on the Home page serves not only as a button, but also displays Burner Control lockouts, holds, and alerts as they occur. The History button can be selected at any time, regardless of which type of information is displayed, to view history information. Pressing the History button displays a dialog box (see Figure 42 on Page 54) that allows the user to select the type of history to view. The user can also silence an audible alarm generated by the control during a lockout or alert by alarm condition.

This History dialog box provides an exploded view of the status information displayed in the History button (the font is larger). One of the four buttons (OK, Lockouts, Alerts, or Silence) can be selected. If none of these buttons are selected the dialog box closes after 30 seconds.

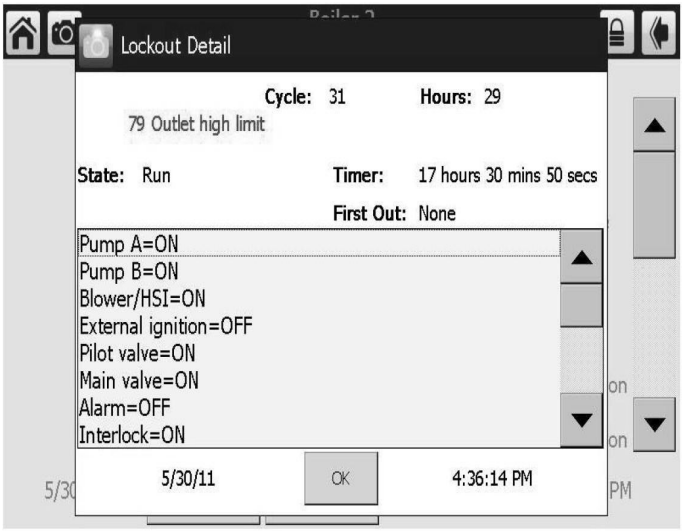


FIGURE 42. EXAMPLE OF HISTORY BUTTON

Two types of historical data can be displayed on the history page: lockout history and alert log.

The entire 15 fault code history is displayed in a scrollable list with the most recent fault displayed first followed by the next most recent fault. Summary information is displayed for each fault entry, including the burner cycle count, fault code, and fault number with description. Detailed information for a specific fault entry that also includes burner control sequence state, burner run-time hours, annunciation status, etc., is viewed by selecting (touching the History line) the lockout entry in the list.

The date and time that each fault occurred is displayed in the lockout history. The lockout timestamp displays in both the lockout summary and detail information.

The Burner Control does not maintain date or time of day information. The date and time stamp is assigned by the OI display. When the OI display first obtains the lockout and alert history from the control (during the display data synchronization), no timestamps are assigned since the times that the lockouts occurred are unknown. All new lockouts that occur after the synchronization are assigned timestamps.

NOTE: The system time can be set in the OI display to ensure that correct timestamps are given to the controls' lockouts and alerts. Power interruptions will require the time to be reset as the display does not have a time backup means.

The Clear Lockout button allows the user to acknowledge and clear (reset) the lockout when in lockout state, much the same as pressing the reset button on the front of the Burner Control.

The user can toggle between displaying the controls' lockout history and alert log by pressing the Alerts or Lockouts button on the bottom of the pages.

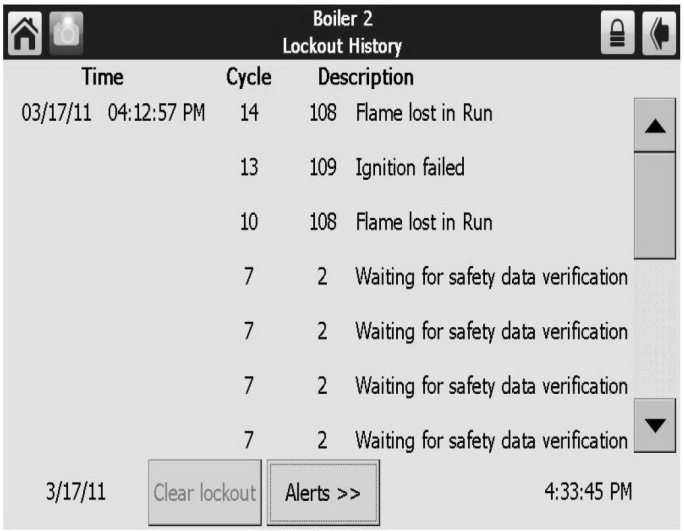


FIGURE 43. EXAMPLE OF LOCKOUT HISTORY

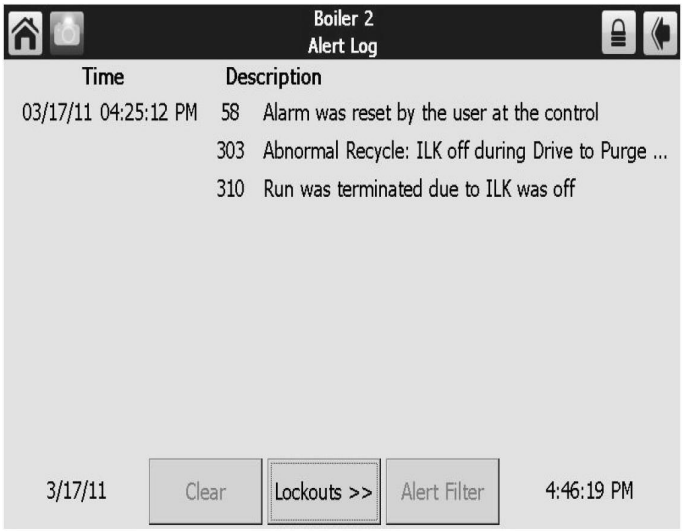


FIGURE 44. EXAMPLE OF ALERT SHOWN

To see additional detail about a lockout or alert, touching on the lockout or alert in the list expands the view of that lockout or alert, as shown in Figure 43 and Figure 44.

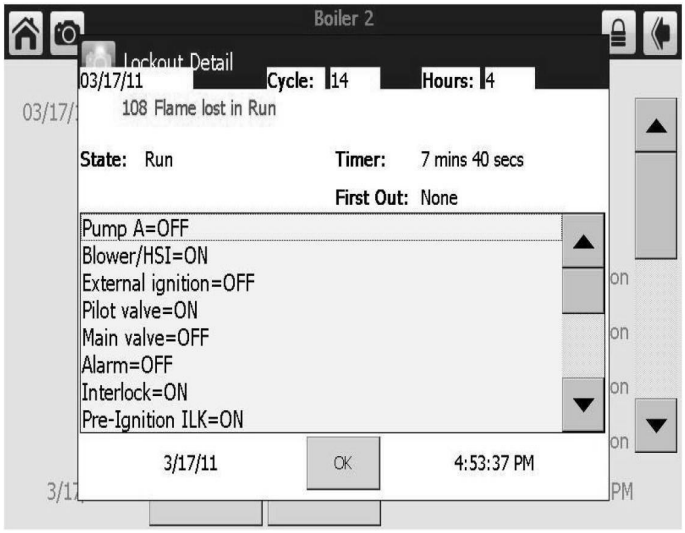


FIGURE 45. CONTROL EXPANDED LOCKOUT DETAIL

FIGURE 46. CONTROL EXPANDED ALERT DETAIL

OPERATION BUTTON

The operation button displays the Burner Control running operation, including setpoint and firing rate values. From this page the user can change setpoints, manually control the boiler/water heater's firing rate, manually turn pumps on, view annunciation information, and switch between hydronic heating loops (Central Heat and Domestic Hot Water), as shown in Figure 47. If a password is required to change any of the settings on this page, the user can press the Login button to enter the password.

Annunciation information is shown in Figure 48 and Figure 49.

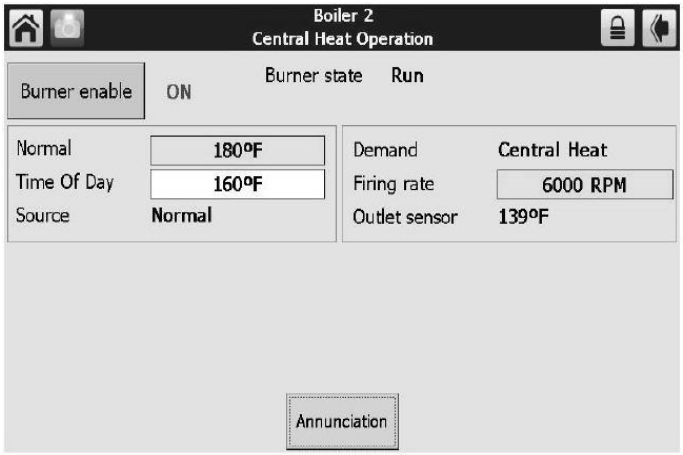


FIGURE 47. OPERATION PAGE

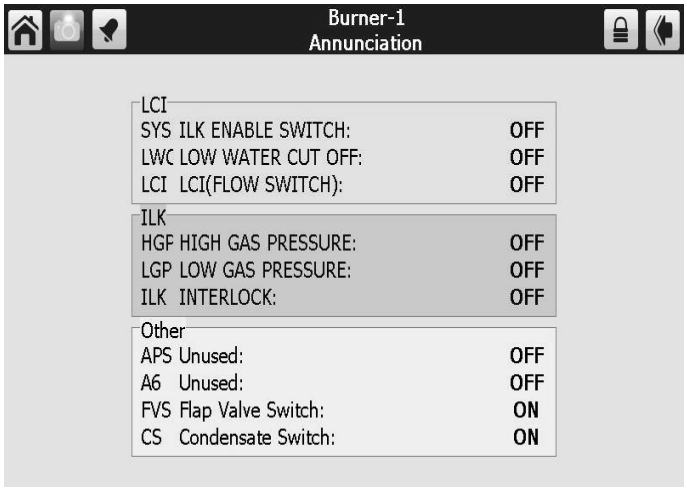


FIGURE 48. PROGRAMMABLE ANNUNCIATION

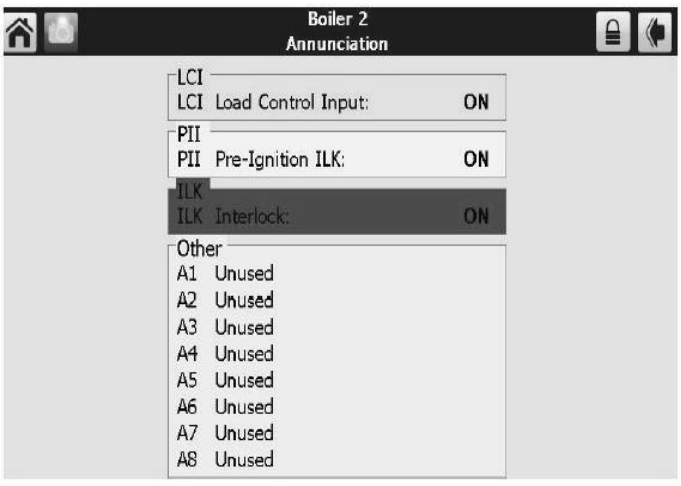


FIGURE 49. PROGRAMMABLE ANNUNCIATION CONT.

DIAGNOSTICS BUTTON

The Diagnostics button displays analog and digital I/O status of the Burner Control and is meant only for diagnostics and troubleshooting purposes. A snapshot of the diagnostic status is displayed and updated once per second as it changes in the control.

The digital I/O data is displayed as LEDs that are either on (green) or off (red) (see Figure 50). Not all digital I/O can be displayed at the same time on the page, so a horizontal scroll bar is used to move the view left and right to show all digital I/O data.

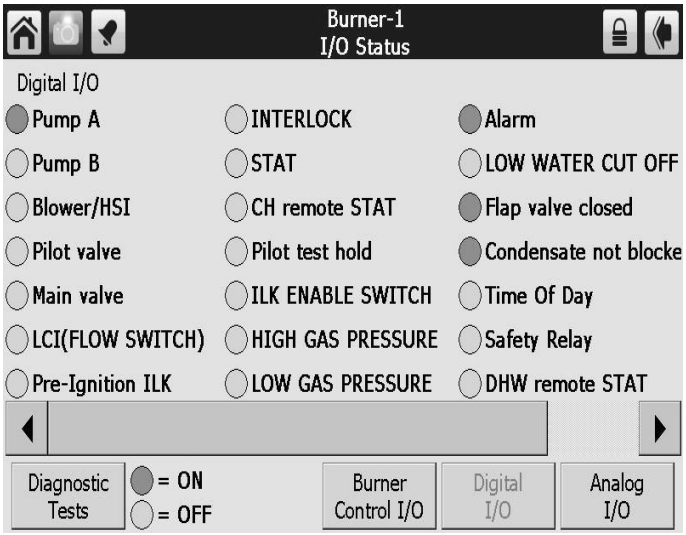


FIGURE 50. DIAGNOSTICS PAGE (DIGITAL I/O)

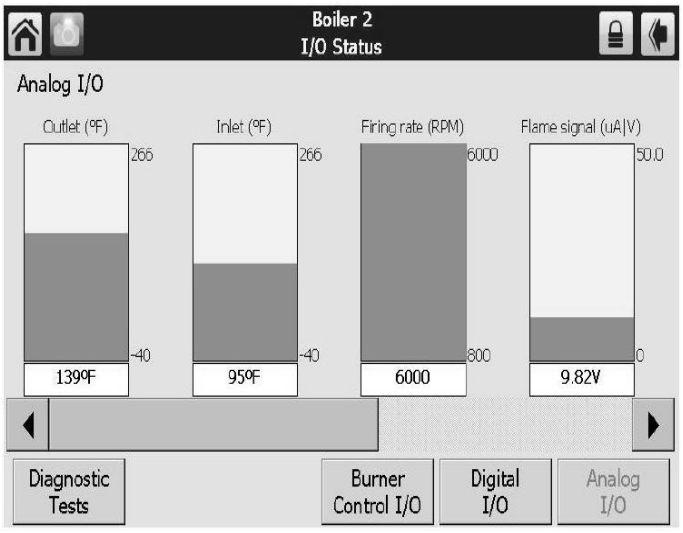


FIGURE 51. DIAGNOSTIC PAGE (ANALOG I/O)

The control analog I/O can also be viewed on the OI Display. A snapshot of the diagnostic status is displayed and updated as it changes in the control.

The analog I/O data is displayed as bar charts with I/O level represented in the I/O range (see Figure 51) Analog I/O that is not enabled for the installation displays a blank I/O level. Not all analog I/O can be displayed at the same time on the page, so a horizontal scroll bar is used to move the view left and right to show all analog I/O status.

SYSTEM CONFIGURATION (S7999D OI DISPLAY ONLY)

The OI Display has some functions related to general configuration for the control in the end user installation. Pressing the Display Refresh button invokes a search procedure (see Figure 52). A new R7910A Hydronic Control is identified by “Unknown” status next to its name in the boiler/water heater system list (see Figure 53). “Unknown” indicates that configuration data has not been retrieved from the control yet.

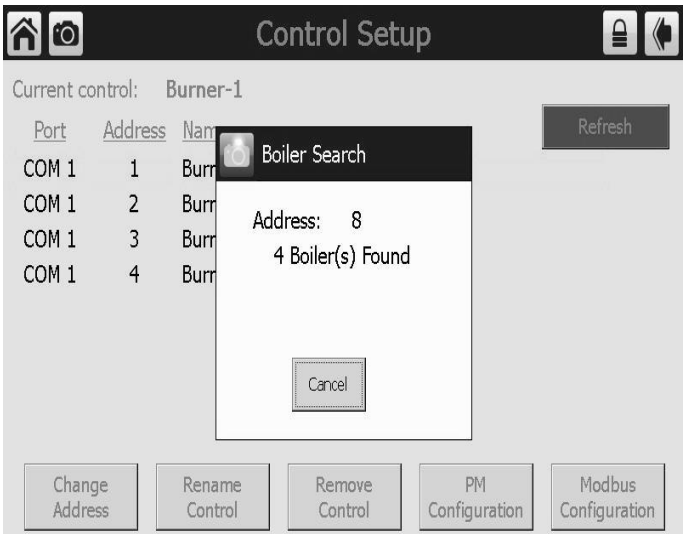


FIGURE 52. SYSTEM REFRESH

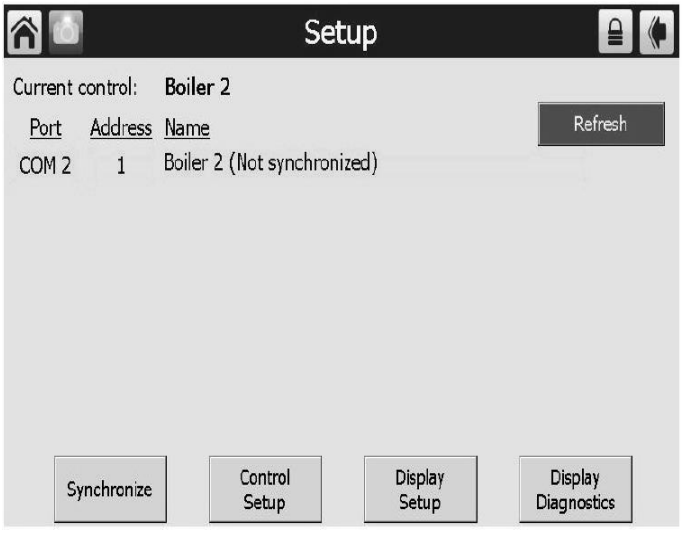


FIGURE 53. SYSTEM CONFIGURATION PAGE

The control connected to the Modbus network is indicated to the user after the search procedure has concluded.

Once the control is located it must be synchronized with the OI Display before it can be displayed. New controls are not displayed on the Home page until this synchronization is performed.

SYSTEM SYNCHRONIZATION (S7999D OI DISPLAY ONLY)

The user can manually synchronize configuration data from the connected controls at any time.

A new control is visible when configuration and status data is gathered from it. This collection procedure takes a few minutes. The control is marked as “Unknown” when no configuration information exists. Normally, control configuration data collection only needs to be performed when the control is initially installed. However, a re synchronization is necessary after the OI Display is reset. See Figure 54.

The user presses the Synchronize button to begin synchronization with the control.

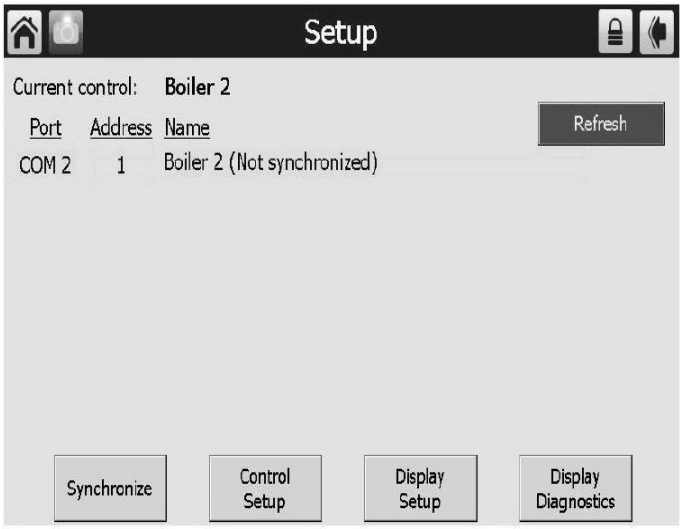


FIGURE 54. SYSTEM SYNCHRONIZATION

Status of the synchronization is reflected in the dialog box. The synchronization can be aborted by selecting the Cancel button.

CONFIGURATION

The Burner Control can be configured from the OI Display. The control configuration is grouped into the functional groups as shown in Table 11.

TABLE 11. FUNCTIONAL CONFIGURATION GROUPS

HYDRONIC CONTROL
System Identification and Access
CH - Central Heat
Outdoor Reset
DHW - Domestic Hot Water
DHW Storage
DHW Plate
Warm Weather Shutdown
Demand Priority
Modulation Configuration
Pump Configuration
Statistics Configuration
High Limit
Stack Limit
Delta T Limits
T-Rise Limit
Heat Exchanger High Limit
Anti-condensation
Frost Protection Configuration
Annunciation Configuration
Burner Control Interlocks
Burner Control Timings and Rates
Burner Control Ignition
Burner Control Flame Failure
System Configuration
Fan Configuration
Sensor Configuration
Lead Lag Slave Configuration
Lead Lag Master Configuration

Most of this configurations are already performed by either the contractor/installer or at A. O. Smith. Each functional group is displayed on the Configuration menu page.

Parameters in functional groups that are not applicable for the installation can be ignored. In some cases, features in a functional group are disabled by default and are enabled when needed for the installation.

TROUBLESHOOTING

The Control System performs exhaustive self diagnostics and displays detected fault conditions in plain English errors/fault messages on the Display System when there is a problem. When the Control System declares a fault condition it will “lock out” and disable boiler/water heater operation.

POOR COMBUSTION - IGNITION FAILURE - ROUGH START/OPERATION

- Ensure the correct type of fuel gas, natural gas or propane, is supplied to the boiler/water heater., see the boiler/water heater's rating label.
- Check supply gas and manifold pressure.
- Inspect the Burner for debris or damage.

If the high and/or low fire CO2 combustion readings are not in accordance with Table 7 on Page 36 and Table 8 on Page 37, or the CO readings are high, or if the boiler/water heater is experiencing ignition failure or rough starting/operation perform the following procedures:

ADEQUATE COMBUSTION AIR - PROPER VENTING

Combustion Air: Carefully review the requirements for combustion and ventilation air in the Instruction Manual that came with the boiler/water heater. Ensure there is an adequate supply of fresh air for combustion and the boiler/water heater is vented properly. Do not overlook this step. Lack of combustion air and improper venting is often the root cause for poor combustion, ignition failure and Control System lock out. Ensure all air requirements listed in the Instruction Manual that came with the boiler/water heater have been observed and followed.

Direct Vent Installations: If the boiler/water heater is using outdoor air for combustion (direct vent) ensure the intake air or the vent pipe is not restricted and neither has exceeded the maximum equivalent feet or maximum number of elbow limitations given in the Instruction Manual that came with the boiler/water heater. Ensure the specified (check parts list) vent and intake air termination fittings have been installed. The factory supplied terminations are critical, failure to install required vent system components will result in operation problems.

If the boiler/water heater is in an equipment room with a door to the outdoors, temporarily disconnect the intake air pipe and prop open the equipment room door. Take combustion readings again to see if this corrects the problem. If the combustion readings improve with the intake air pipe disconnected, the intake air pipe is either restricted or has too many equivalent feet or too many elbows installed.

Conventional Vent Installations: If the boiler/water heater is using room air for combustion (conventional vent) ensure the vent pipe is not restricted and has not exceeded the maximum equivalent feet or maximum number of elbow limitations given in the Instruction Manual that came with the boiler/water heater. Ensure the specified (check parts list) vent termination fitting has been installed. The required termination are critical, failure to install required vent system components will result in operation problems.

Ensure the fresh air openings in the equipment room are adequately sized for the combined input Btu/hr rating of all conventionally vented fuel burning appliances in the room. If the boiler/water heater is in an equipment room with a door to the outdoors - prop open the equipment room door. Take combustion readings again to see if this corrects the problem. If the combustion readings improve with the door open the fresh air openings may be undersized, refer to Air Requirements in the Instruction Manual to correct the problem.

Service Note

If the Instruction Manual that came with the boiler/water heater is not on hand or there is any questions regarding the Air Requirements or Venting instructions; call the toll free support phone number on the back cover of this manual for further assistance. Costs to correct installation errors are not covered under the limited warranty.

VENT GAS RECIRCULATION

Vent gases recirculating from the vent termination into the intake air termination on direct vent installations is a serious installation problem that **MUST BE** corrected. It will cause poor combustion, high Carbon Monoxide (CO) levels, delayed ignition, rough starting/operation and ignition failure. Costs to correct installation errors are not covered under the limited warranty.

Vent and intake air terminations on direct vent installations may be allowing the recirculation of vent gases to the intake air pipe. Ensure both terminations on direct vent installations have been installed with adequate clearances. See the Instruction Manual that came with the boiler/water heater for venting instructions and vent/intake air termination clearance requirements.

RESTORE GAS FLOW SETTINGS TO DEFAULT

Each XB boiler/XWH water heater is fired and the optimal combustion set before leaving the factory. The High and Low Fire gas flow adjustment screws on the 24 VAC Gas Valve have been set to maximize the boiler/water heater performance. When performing the on site Start-up, gas flow can be improperly adjusted to the point the boiler/water heater will not light. This may require the valve to be reset to a minimum gas flow (default) setting that will allow the unit to safely fire and perform the necessary adjustments outlined in the Start-up procedure to ensure proper combustion and performance. Follow these steps to reset the gas flow settings to the minimum gas flow (default) settings:

- With the boiler/water heater turned off. Use the correct size TORX® and/or Allen wrench to adjust the high fire and low fire adjustment screws on the 24 VAC Gas Valve. Turn the High Fire adjustment screw clockwise and the Low Fire adjustment screw counter-clockwise until they will not turn any more. This will close both gas flow adjustment screws. Do not overtighten or use excessive force, turn the adjustment screws until they stop with minimal force applied.
- With both adjustment screws closed, turn the High Fire adjustment screw counter-clockwise 2 1/2 turns and the Low Fire adjustment screw clockwise 2 1/2 turns. The gas flow settings are now reset to the minimum gas flow (default) setting.
- The boiler/water heater should light off with these minimum gas flow (default) settings. Make final gas flow adjustments and ensure proper combustion and performance. If the boiler/water heater will not light off with the gas flow adjustment screws reset as described above call the toll free support phone number on the back cover of this manual for further assistance.

BURNER INSPECTION

The stainless steel radial fire Burner used in XB boilers/XWH water heaters can trap debris drawn into the combustion air intake. This can cause poor combustion, rough starting/operation and ignition failure. When cutting the intake air pipe sections during installation, carefully remove all plastic debris left on the ends of each pipe section before installation to avoid this problem.

- Turn off the power supply. Disconnect the Venturi from the Combustion Blower. See Figure 7 on Page 15.
- Unplug the 3 pin and 5 pin plugs to the Combustion Blower Assembly. See Figure 4 on Page 11.
- Remove the Combustion Blower to get access to the Burner.
- Remove the Burner and inspect the burner for any signs of damage or debris inside. If the burner is damaged or contaminated with debris - replace the burner. Check all gaskets in the burner/blower assembly for wear or damage. Replace any worn or damaged gaskets.

Service Note

If the boiler/water heater is still experiencing poor combustion, rough starting/operating or ignition failure after all the steps in this section have been performed call the toll free support phone number on the back cover of this manual for further assistance.

THINGS TO CHECK BEFORE SERVICING:

- Using the Instruction Manual that came with the boiler/water heater as reference, verify the water piping, gas line, venting and electrical have all been properly installed.
- Ensure the power supply connections to the boiler/water heater are polarity correct and are properly grounded.
- Ensure supply gas pressure is within the minimum and maximum requirements.
- Review the Installation Considerations on page 3 and the Installation Check List on Page 8.

NOTE: Poor installations account for many service problems. Costs to correct installation errors are not covered under the limited warranty.

RESETTING THE CONTROL SYSTEM

To reset the Control System from a lock out/fault condition; turn the power supply off for approximately 20 seconds and then back on. Keep in mind if the condition that caused the lock out has not been corrected the Control System will continue to lock out.

IMPORTANT SERVICE REMINDER

When performing any troubleshooting step outlined in this manual always consider the wiring and connectors between components. Perform a close visual inspection of all wiring and connectors to and from a given component before replacement. Ensure wires were stripped before being crimped in a wire connector, ensure wires are crimped tightly in their connectors, ensure connection pins in sockets and plugs are not damaged or worn, ensure plugs and sockets are mating properly and providing good contact. Failure to perform this critical step or failing to perform this step thoroughly often results in needless down time, unnecessary parts replacement, and customer dissatisfaction.

TROUBLESHOOTING CODES

To support the recommended Troubleshooting, the R7910 has an Alert File. Review the Alert history for possible trends that may have been occurring prior to the actual Lockout.
Note Column: H= Hold message; L=Lockout message; H or L= either Hold or Lockout depending on Parameter Configuration.

TABLE 12. TROUBLESHOOTING CODES

CODE	DESCRIPTION	RECOMMENDED TROUBLESHOOTING OF LOCKOUT CODES	NOTE
	Safety Data Faults		
1	Unconfigured safety data	1. New Device, complete device configuration and safety verification. 2. If fault repeats, replace module.	L
2	Waiting for safety data verification	1. Device in Configuration mode and safety parameters need verification and a device needs reset to complete verification. 2. Configuration ended without verification, re enter configuration, verify safety parameters and reset device to complete verification. 3. If fault repeats, replace module.	L
	Internal Operation Errors		
3	Internal fault: Hardware fault	Internal Fault. 1. Reset Module. 2. If fault repeats, replace module.	H
4	Internal fault: Safety Relay key feedback error		H
5	Internal fault: Unstable power (DCDC) output		H
6	Internal fault: Invalid processor clock		H
7	Internal fault: Safety relay drive error		H
8	Internal fault: Zero crossing not detected		H
9	Internal fault: Flame bias out of range		H
10	Internal fault: Invalid Burner control state		L
11	Internal fault: Invalid Burner control state flag		L
12	Internal fault: Safety relay drive cap short		H
13	Internal fault: PII shorted to ILK		H or L
14	Internal fault: HFS shorted to LCI		H or L
15	Internal fault: Safety relay test failed due to feedback ON		L
16	Internal fault: Safety relay test failed due to safety relay OFF		L
17	Internal fault: Safety relay test failed due to safety relay not OFF		L
18	Internal fault: Safety relay test failed due to feedback not ON		L
19	Internal fault: Safety RAM write		L
20	Internal fault: Flame ripple and overflow		H
21	Internal fault: Flame number of sample mismatch		H
22	Internal fault: Flame bias out of range		H
23	Internal fault: Bias changed since heating cycle starts		H
24	Internal fault: Spark voltage stuck low or high		H
25	Internal fault: Spark voltage changed too much during flame sensing time		H
26	Internal fault: Static flame ripple		H
27	Internal fault: Flame rod shorted to ground detected		H
28	Internal fault: A/D linearity test fails		H
29	Internal fault: Flame bias cannot be set in range		H

CODE	DESCRIPTION	RECOMMENDED TROUBLESHOOTING OF LOCKOUT CODES	NOTE
30	Internal fault: Flame bias shorted to adjacent pin	Internal Fault. 1. Reset Module. 2. If fault repeats, replace module.	H
31	Internal fault: SLO electronics unknown error		H
32 - 46	Internal fault: Safety Key 0 through 14		L
	System Errors		
47	Flame Rod to ground leakage		H
48	Static flame (not flickering)		H
49	24VAC voltage low/high	1. Check the Module and display connections. 2. Check the Module power supply and make sure that both frequency, voltage and VA meet the specifications.	H
50	Modulation fault	Internal sub-system fault. 1. Review alert messages for possible trends. 2. Correct possible problems. 3. If fault persists, replace module.	H
51	Pump fault		H
52	Motor tachometer fault		H
53	AC inputs phase reversed	1. Check the Module and display connections. 2. Check the Module power supply and make sure that both frequency and voltage meet the specifications. 3. On 24Vac applications, assure that J4-10 and J8-2 are connected together.	L
54	Safety GVT model ID does not match application's model ID	Contact the qualified service technician.	L
55	Application configuration data block CRC errors	Contact the qualified service technician.	L
56 - 57	RESERVED		
58	Internal fault: HFS shorted to IAS	Internal Fault. 1. Reset Module. 2. If fault repeats, replace module.	L
59	Internal Fault: Mux pin shorted		L
	Normal Event Status		
60	Internal Fault: HFS shorted to LFS		L
61	Anti short cycle	Will not be a lockout fault. Hold Only.	H
62	Fan speed not proved		H
63	LCI OFF	1. Check wiring and correct any faults. 2. Check Interlocks connected to the LCI to assure proper function. 3. Reset and sequence the module; monitor the LCI status. 4. If code persists, replace the module.	H
64	PII OFF	1. Check wiring and correct any faults. 2. Check Preignition Interlock switches to assure proper functioning. 3. Check the valve operation. 4. Reset and sequence the module; monitor the PII status. 5. If code persists, replace the module.	H or L
65	Interrupted Airflow Switch OFF	1. Check wiring and correct any possible shorts. 2. Check airflow switches to assure proper functioning. 3. Check the fan/blower operation. 4. Reset and sequence the module; monitor the airflow status. 5. If code persists, replace the module.	H or L
66	Interrupted Airflow Switch ON		H or L

CODE	DESCRIPTION	RECOMMENDED TROUBLESHOOTING OF LOCKOUT CODES	NOTE
67	ILK OFF	1. Check wiring and correct any possible shorts. 2. Check Interlock (ILK) switches to assure proper function. 3. Verify voltage through the interlock string to the interlock input with a voltmeter. 4. If steps 1-3 are correct and the fault persists, replace the module.	H or L
68	ILK ON		H or L
69	Pilot test hold	1. Verify Run/Test is changed to Run. 2. Reset Module. 3. If fault repeats, replace module.	H
70	Wait for leakage test completion	1. Internal Fault. Reset Module. 2. If fault repeats, replace module.	H
71 - 77	RESERVED		
78	Demand Lost in Run	1. Check wiring and correct any possible errors. 2. If previous steps are correct and fault persists, replace the module.	H
79	Outlet high limit	1. Check wiring and correct any possible errors. 2. Replace the Outlet high limit. 3. If previous steps are correct and fault persists, replace the module.	H or L
80	DHW high limit	1. Check wiring and correct any possible errors. 2. Replace the DHW high limit. 3. If previous steps are correct and fault persists, replace the module.	H or L
81	Delta T limit	1. Check Inlet and Outlet sensors and pump circuits for proper operation. 2. Recheck the Delta T Limit to confirm proper setting. 3. If previous steps are correct and fault persists, replace the module.	H or L
82	Stack limit	1. Check wiring and correct any possible errors. 2. Replace the Stack high limit. 3. If previous steps are correct and fault persists, replace the module.	H or L
83	Delta T exchanger/outlet limit	Not Applicable.	H or L
84	Delta T inlet/exchanger limit	Not Applicable.	H or L
85	Inlet/outlet inversion limit	Not Applicable.	H or L
86	Exchanger/outlet inversion limit	Not Applicable.	H or L
87	Inlet/exchanger inversion limit	Not Applicable.	H or L
88	Outlet T-rise limit	1. Check for adequate flow.	H or L
89	Exchanger T-rise limit	Not Applicable.	H or L
90	Heat exchanger high limit	Not Applicable.	H or L
	Sensor Faults		
91	Inlet sensor fault	1. Check wiring and correct any possible errors. 2. Replace the Inlet sensor. 3. If previous steps are correct and fault persists, replace the module.	H
92	Outlet sensor fault	1. Check wiring and correct any possible errors. 2. Replace the Outlet sensor. 3. If previous steps are correct and fault persists, replace the module.	H
93	DHW sensor fault	1. Check wiring and correct any possible errors. 2. Replace the DHW sensor. 3. If previous steps are correct and fault persists, replace the module.	H

CODE	DESCRIPTION	RECOMMENDED TROUBLESHOOTING OF LOCKOUT CODES	NOTE
94	Header sensor fault	1. Check wiring and correct any possible errors. 2. Replace the header sensor. 3. If previous steps are correct and fault persists, replace the module.	H
95	Stack sensor fault	1. Check wiring and correct any possible errors. 2. Replace the stack sensor. 3. If previous steps are correct and fault persists, replace the module.	H
96	Outdoor sensor fault	1. Check wiring and correct any possible errors. 2. Replace the outdoor sensor. 3. If previous steps are correct and fault persists, replace the module.	H
97	Internal Fault: A2D mismatch	Internal Fault. 1. Reset Module. 2. If fault repeats, replace module.	L
98	Internal Fault: Exceeded VSNSR voltage		L
99	Internal Fault: Exceeded 28V voltage tolerance		L
100	Pressure Sensor Fault	1. Verify the Pressure Sensor is a 4-20ma source. 2. Check wiring and correct any possible errors. 3. Test Pressure Sensor for correct operation. 4. Replace the Pressure sensor. 5. If previous steps are correct and fault persists, replace the module.	H
101-104	RESERVED		
	Flame Operation Faults		
105	Flame detected out of sequence	1. Check that flame is not present in the combustion chamber. Correct any errors. 2. Make sure that the flame detector is wired to the correct terminal. 3. Make sure the F & G wires are protected from stray noise pickup. 4. Reset and sequence the module, if code reappears, replace the flame detector. 5. Reset and sequence the module, if code reappears, replace the module.	H or L
106	Flame lost in MFEP	1. Check pilot valve (Main Valve for DSI) wiring and operation - correct any errors. 2. Check the fuel supply. 3. Check fuel pressure and repeat turndown tests. 4. Check ignition transformer electrode, flame detector, flame detector siting or flame rod position. 5. If steps 1 through 4 are correct and the fault persists, replace the module.	L
107	Flame lost early in run		L
108	Flame lost in run		L
109	Ignition failed		L
110	Ignition failure occurred	Hold time of recycle and hold option. Will not be a lockout fault. Hold Only.	H
111	Flame current lower than WEAK threshold	Internal hardware test. Not a lockout.	H
112	Pilot test flame timeout	Interrupted Pilot or DSI application and flame lost when system in “test” mode. 1. Reset the module to restart.	L
113	Flame circuit timeout	Flame sensed during Initiate or off cycle, hold 240 seconds, if present after 240 seconds, lockout.	L
114-116	RESERVED		
117	Condensate Fault	1. Check the condensate trap at the back of the boiler/water heater for any blockage. 2. Check the exhaust vent piping for any blockage.	L
118-121	RESERVED		
	Rate Proving Faults		

CODE	DESCRIPTION	RECOMMENDED TROUBLESHOOTING OF LOCKOUT CODES	NOTE
122	Lightoff rate proving failed	1. Check wiring and correct any potential wiring errors. 2. Check VFDs ability to change speeds. 3. Change the VFD. 4. If the fault persists, replace the module.	L
123	Purge rate proving failed		L
124	High fire switch OFF	1. Check wiring and correct any potential wiring errors. 2. Check High Fire Switch to assure proper function (not welded or jumpered). 3. Manually drive the motor to the High Fire position and adjust the HF switch while in this position and verify voltage through the switch to the HFS input with a voltmeter. 4. If steps 1-3 are correct and the fault persists, replace the module.	H
125	High fire switch stuck ON		H
126	Low fire switch OFF	1. Check wiring and correct any potential wiring errors. 2. Check Low Fire Switch to assure proper function (not welded or jumpered). 3. Manually drive the motor to the High Fire position and adjust the LF switch while in this position and verify voltage through the switch to the LFS input with a voltmeter. 4. If steps 1-3 are correct and the fault persists, replace the module.	H
127	Low fire switch stuck ON		H or L
128	Fan speed failed during prepurge	1. Check wiring and correct any potential wiring errors. 2. Check VFDs ability to change speeds. 3. Change the VFD. 4. If the fault persists, replace the module.	H or L
129	Fan speed failed during preignition		H or L
130	Fan speed failed during ignition		H or L
131	Fan movement detected during standby		H
132	Fan speed failed during run		H
133-135	RESERVED		
	Start Check Faults		
136	Interrupted Airflow Switch failed to close	1. Check wiring and correct any possible wiring errors. 2. Check Interrupted Airflow switch(es) to assure proper function. 3. Verify voltage through the airflow switch to the IAS input with a voltmeter. 4. If steps 1-3 are correct and the fault persists, replace the module.	H
137	ILK failed to close	1. Check wiring and correct any possible shorts. 2. Check Interlock (ILK) switches to assure proper function. 3. Verify voltage through the interlock string to the interlock input with a voltmeter. 4. If steps 1-3 are correct and the fault persists, replace the module.	H
138-142	RESERVED		
	FAULT CODES 149 THROUGH 165 ARE OEM SPECIFIC FAULT CODES		
143	Internal fault: Flame bias out of range 1	Contact the qualified service technician.	L
144	Internal fault: Flame bias out of range 2	Contact the qualified service technician.	L
145	Internal fault: Flame bias out of range 3	Contact the qualified service technician.	L
146	Internal fault: Flame bias out of range 4	Contact the qualified service technician.	L
147	Internal fault: Flame bias out of range 5	Contact the qualified service technician.	L
148	Internal fault: Flame bias out of range 6	Contact the qualified service technician.	L

CODE	DESCRIPTION	RECOMMENDED TROUBLESHOOTING OF LOCKOUT CODES	NOTE
149	Flame detected	OEM Specific. 1. Holds if flame detected during Safe Start check up to Flame Establishing period.	H or L
150	Flame not detected	OEM Specific. 1. Sequence returns to standby and restarts sequence at the beginning of Purge after the HF switch opens. If flame detected during Safe Start check up to Flame Establishing period.	H
151	High fire switch ON	OEM Specific. 1. Check wiring and correct any potential wiring errors. 2. Check High Fire Switch to assure proper function (not welded or jumpered). 3. Manually drive the motor to the High Fire position and adjust the HF switch while in this position and verify voltage through the switch to the HFS input with a voltmeter. 4. If steps 1-3 are correct and the fault persists, replace the module.	H or L
152	Combustion pressure ON	OEM Specific. 1. Check wiring and correct any errors. 2. Inspect the Combustion Pressure Switch to make sure it is working correctly. 3. Reset and sequence the relay module. 4. During STANDBY and PREPURGE, measure the voltage between Terminal J6-5 and L2 (N). Supply voltage should be present. If not, the lockout switch is defective and needs replacing. 5. If the fault persists, replace the relay module.	H or L
153	Combustion pressure Off		H or L
154	Purge Fan switch On	OEM Specific. 1. Purge fan switch is on when it should be off.	H or L
155	Purge Fan switch Off		H
156	Combustion pressure and Flame ON	OEM Specific. 1. Check that flame is not present in the combustion chamber. Correct any errors. 2. Make sure that the flame detector is wired to the correct terminal. 3. Make sure the F & G wires are protected from stray noise pickup. 4. Reset and sequence the module, if code reappears, replace the flame detector.	H or L
157	Combustion pressure and Flame OFF		L
158	Main valve ON	OEM Specific. 1. Check Main Valve terminal wiring and correct any errors. 2. Reset and sequence the module. If fault persist, replace the module.	L
159	Main valve OFF		L
160	Ignition ON	OEM Specific. 1. Check Ignition terminal wiring and correct any errors. 2. Reset and sequence the module. If fault persist, replace the module.	L
161	Ignition OFF		L
162	Pilot valve ON	OEM Specific. 1. Check Pilot Valve terminal wiring and correct any errors. 2. Reset and sequence the module. If fault persist, replace the module.	L
163	Pilot valve OFF		L

CODE	DESCRIPTION	RECOMMENDED TROUBLESHOOTING OF LOCKOUT CODES	NOTE
164	Block intake ON	OEM Specific. 1. Check wiring and correct any errors. 2. Inspect the Block Intake Switch to make sure it is working correctly. 3. Reset and sequence the module. 4. During Standby and Purge, measure the voltage across the switch. Supply voltage should be present. If not, the Block Intake Switch is defective and needs replacing. 5. If the fault persists, replace the relay module.	L
165	Block intake OFF		L
166-171	RESERVED		
	Feedback		
172	Main relay feedback incorrect	Internal Fault. 1. Reset Module. 2. If fault repeats, replace module.	L
173	Pilot relay feedback incorrect		L
174	Safety relay feedback incorrect		L
175	Safety relay open		L
176	Main relay ON at safe start check		L
177	Pilot relay ON at safe start check		L
178	Safety relay ON at safe start check		L
179-183	RESERVED		
	Parameter Faults		
184	Invalid BLOWER/HSI output setting	1. Return to Configuration mode and recheck selected parameters, reverify and reset module. 2. If fault repeats, verify electrical grounding. 3. If fault repeats, replace module.	L
185	Invalid Delta T limit enable setting		L
186	Invalid Delta T limit response setting		L
187	Invalid DHW high limit enable setting		L
188	Invalid DHW high limit response setting		L
189	Invalid Flame sensor type setting		L
190	Invalid interrupted air switch enable setting		L
191	Invalid interrupted air switch start check enable setting		L
192	Invalid igniter on during setting		L
193	Invalid ignite failure delay setting		L
194	Invalid ignite failure response setting	1. Return to Configuration mode and recheck selected parameters, reverify and reset module. 2. If fault repeats, verify electrical grounding. 3. If fault repeats, replace module.	L
195	Invalid ignite failure retries setting		L
196	Invalid ignition source setting		L
197	Invalid interlock open response setting		L
198	Invalid interlock start check setting		L
199	Invalid LCI enable setting		L
200	Invalid lightoff rate setting		L
201	Invalid lightoff rate proving setting		L
202	Invalid Main Flame Establishing Period time		L
203	Invalid MFEP flame failure response setting		L
204	Invalid NTC sensor type setting		L
205	Invalid Outlet high limit response setting		L
206	Invalid Pilot Flame Establishing Period setting		L
207	Invalid PII enable setting		L
208	Invalid pilot test hold setting		L
209	Invalid Pilot type setting		L
210	Invalid Postpurge time setting		L
211	Invalid Power up with lockout setting		L

CODE	DESCRIPTION	RECOMMENDED TROUBLESHOOTING OF LOCKOUT CODES	NOTE
212	Invalid Preignition time setting	1. Return to Configuration mode and recheck selected parameters, reverify and reset module. 2. If fault repeats, verify electrical grounding. 3. If fault repeats, replace module.	L
213	Invalid Prepurge rate setting		L
214	Invalid Prepurge time setting		L
215	Invalid Purge rate proving setting		L
216	Invalid Run flame failure response setting		L
217	Invalid Run stabilization time setting		L
218	Invalid Stack limit enable setting		L
219	Invalid Stack limit response setting		L
220	Unconfigured Delta T limit setpoint setting		L
221	Unconfigured DHW high limit setpoint setting		L
222	Unconfigured Outlet high limit setpoint setting		L
223	Unconfigured Stack limit setpoint setting		L
224	Invalid DHW demand source setting		L
225	Invalid Flame threshold setting		L
226	Invalid Outlet high limit setpoint setting		L
227	Invalid DHW high limit setpoint setting		L
228	Invalid Stack limit setpoint setting		L
229	Invalid Modulation output setting		L
230	Invalid CH demand source setting		L
231	Invalid Delta T limit delay setting		L
232	Invalid Pressure sensor type setting		L
233	Invalid IAS closed response setting		L
234	Invalid Outlet high limit enable setting	Contact the qualified service technician.	L
235	Invalid Outlet connector type setting	Contact the qualified service technician.	L
236	Invalid Inlet connector type setting	Contact the qualified service technician.	L
237	Invalid DHW connector type setting	Contact the qualified service technician.	L
238	Invalid Stack connector type setting	Contact the qualified service technician.	L
239	Invalid S2 (J8-6) connector type setting	Contact the qualified service technician.	L
240	Invalid S5 (J8-11) connector type setting	Contact the qualified service technician.	L
241	Exchanger sensor not allowed with stack connector setting	Not Applicable.	L
242	Invalid DHW auto detect configuration	Not Applicable.	L
243	Invalid UV with spark interference not compatible with Ignitor on throughout PFEP	Contact the qualified service technician.	L
244	Internal fault: Safety relay test invalid state	Contact the qualified service technician.	L
245	Invalid Outlet connector type setting for Trise	Contact the qualified service technician.	L
246	4-20mA cannot be used for both modulation and setpoint control	Contact the qualified service technician.	L
247	Invalid ILK bounce detection enable	Not Applicable.	L
248	Invalid forced recycle interval	Not Applicable.	L
249	STAT cannot be demand source when Remote Stat is enabled	Not Applicable.	L
250	Invalid Fan speed error response	1. Check fan cables secured properly. If fault persists contact the qualified service technician.	L
251-255	RESERVED		

TABLE 13. ALERTS

CODE	DESCRIPTION
	EE Management Faults
0	None (No alert)
1	Alert PCB was restored from factory defaults
2	Safety configuration parameters were restored from factory defaults
3	Configuration parameters were restored from factory defaults
4	Invalid Factory Invisibility PCB was detected
5	Invalid Factory Range PCB was detected
6	Invalid range PCB record has been dropped
7	EEPROM lockout history was initialized
8	Switched application annunciation data blocks
9	Switched application configuration data blocks
10	Configuration was restored from factory defaults
11	Backup configuration settings was restored from active configuration
12	Annunciation configuration was restored from factory defaults
13	Annunciation configuration was restored from backup
14	Safety group verification table was restored from factory defaults
15	Safety group verification table was updated
16	Invalid Parameter PCB was detected
17	Invalid Range PCB was detected
	System Parameter Errors
18	Alarm silence time exceeded maximum
19	Invalid safety group verification table was detected
20	Backdoor Password could not be determined
21	Invalid safety group verification table was not accepted
22	CRC errors were found in application configuration data blocks
23	Backup Alert PCB was restored from active one
24	RESERVED
25	Lead Lag operation switch was turned OFF
26	Lead Lag operation switch was turned ON
27	Safety processor was reset
28	Application processor was reset
29	Burner switch was turned OFF
30	Burner switch was turned ON
31	Program Module (PM) was inserted into socket
32	Program Module (PM) was removed from socket
33	Alert PCB was configured
34	Parameter PCB was configured
35	Range PCB was configured
36	Program Module (PM) incompatible with product was inserted into socket

CODE	DESCRIPTION
37	Program Module application parameter revision differs from application processor
38	Program Module safety parameter revision differs from safety processor
39	PCB incompatible with product contained in Program Module
40	Parameter PCB in Program Module is too large for product
41	Range PCB in Program Module was too large for product
42	Alert PCB in Program Module was too large for product
43	IAS start check was forced on due to IAS enabled
	System Operation Faults
44	Low voltage was detected in safety processor
45	High line frequency occurred
46	Low line frequency occurred
47	Invalid subsystem reset request occurred
48	Write large enumerated Modbus register value was not allowed
49	Maximum cycle count was reached
50	Maximum hours count was reached
51	Illegal Modbus write was attempted
52	Modbus write attempt was rejected (NOT ALLOWED)
53	Illegal Modbus read was attempted
54	Safety processor brown-out reset occurred
55	Application processor watchdog reset occurred
56	Application processor brown-out reset occurred
57	Safety processor watchdog reset occurred
58	Alarm was reset by the user at the control
	Demand/Rate Command Faults
59	Burner control firing rate was > absolute max rate
60	Burner control firing rate was < absolute min rate
61	Burner control firing rate was invalid, % vs. RPM
62	Burner control was firing with no fan request
63	Burner control rate (nonfiring) was > absolute max rate
64	Burner control rate (nonfiring) was < absolute min rate
65	Burner control rate (nonfiring) was absent
66	Burner control rate (nonfiring) was invalid, % vs.RPM
67	Fan off cycle rate was invalid, % vs. RPM
68	Setpoint was overridden due to sensor fault
69	Modulation was overridden due to sensor fault
70	No demand source was set due to demand priority conflicts
71-73	RESERVED

CODE	DESCRIPTION
	Fan Parameter Errors
74	Periodic Forced Recycle
75	Absolute max fan speed was out of range
76	Absolute min fan speed was out of range
77	Fan gain down was invalid
78	Fan gain up was invalid
79	Fan minimum duty cycle was invalid
80	Fan pulses per revolution was invalid
81	Fan PWM frequency was invalid
82-83	RESERVED
	Modulation Parameter Errors
84	Lead Lag CH 4-20mA water temperature setting
85	No Lead Lag add stage error threshold was configured
86	No Lead Lag add stage detection time was configured
87	No Lead Lag drop stage error threshold was configured
88	No Lead Lag drop stage detection time was configured
89	RESERVED
90	Modulation output type was invalid
91	Firing rate control parameter was invalid
92	Forced rate was out of range vs. min/max modulation
93	Forced rate was invalid, % vs. RPM
94	Slow start ramp value was invalid
95	Slow start degrees value was invalid
96	Slow start was ended due to outlet sensor fault
97	Slow start was end due to reference setpoint fault
98	CH max modulation rate was invalid, % vs. RPM
99	CH max modulation rate was > absolute max rate
100	CH modulation range (max minus min) was too small (< 4% or 40 RPM)
101	DHW max modulation rate was invalid, % vs.RPM
102	DHW max modulation rate was > absolute max rate
103	DHW modulation range (max minus min) was too small (< 4% or 40 RPM)
104	Min modulation rate was < absolute min rate
105	Min modulation rate was invalid, % vs. RPM
106	Manual rate was invalid, % vs. RPM
107	Slow start enabled, but forced rate was invalid
108	Analog output hysteresis was invalid
109	Analog modulation output type was invalid
110	IAS open rate differential was invalid
111	IAS open step rate was invalid
112	MIX max modulation rate was invalid, % vs. RPM
113	MIX max modulation rate was >absolute max or < absolute min rates

CODE	DESCRIPTION
114	MIX modulation range (max minus min) was too small (< 4% or 40 RPM)
	Modulation Operation Faults
115	Fan was limited to its minimum duty cycle
116	Manual rate was > CH max modulation rate
117	Manual rate was > DHW max modulation rate
118	Manual rate was < min modulation rate
119	Manual rate in Standby was > absolute max rate
120	Modulation commanded rate was > CH max modulation rate
121	Modulation commanded rate was > DHW max modulation rate
122	Modulation commanded rate was < min modulation rate
123	Modulation rate was limited due to outlet limit
124	Modulation rate was limited due to Delta-T limit
125	Modulation rate was limited due to stack limit
126	Modulation rate was limited due to anticondensation
127	Fan Speed out of range in RUN
128	Modulation rate was limited due to IAS was open
129	Slow start ramp setting of zero will result in no modulation rate change
130	No forced rate was configured for slow start ramp
	CH parameter Errors
131	CH demand source was invalid
132	CH P-gain was invalid
133	CH I-gain was invalid
134	CH D-gain was invalid
135	CH OFF hysteresis was invalid
136	CH ON hysteresis was invalid
137	CH sensor type was invalid
138	CH hysteresis step time was invalid
139	CH remote control parameter was invalid
140	CH ODR not allowed with remote control
141	Steam P-gain was invalid
142	Steam I-gain was invalid
143	Steam D-gain was invalid
144	Steam OFF hysteresis was invalid
145	Steam ON hysteresis was invalid
	CH Operation Faults
146	CH control was suspended due to fault
147	CH header temperature was invalid
148	CH outlet temperature was invalid
149	CH steam pressure was invalid
	CH Parameter errors (continued)
150	Steam setpoint source parameter was invalid
151	Minimum water temperature parameter was greater than setpoint

CODE	DESCRIPTION
152	Minimum water temperature parameter was greater than time of day setpoint
153	Minimum pressure parameter was greater than setpoint
154	Minimum pressure parameter was greater than time of day setpoint
155	CH modulation rate source parameter was invalid
156	Steam modulation rate source parameter was invalid
	DHW Parameter Errors
157	DHW demand source was invalid
158	DHW P-gain was invalid
159	DHW I-gain was invalid
160	DHW D-gain was invalid
161	DHW OFF hysteresis was invalid
162	DHW ON hysteresis was invalid
163	DHW hysteresis step time was invalid
164	DHW sensor type was invalid
165	Inlet sensor type was invalid for DHW
166	Outlet sensor type was invalid for DHW
167	DHW Storage OFF hysteresis was invalid
168	DHW Storage ON hysteresis was invalid
169	DHW modulation sensor type was invalid
170	DHW modulation sensor was not compatible for AUTO mode
	DHW Operation Faults
171	DHW control was suspended due to fault
172	DHW temperature was invalid
173	DHW inlet temperature was invalid
174	DHW outlet temperature was invalid
175	DHW high limit must be disabled for AUTO mode
176	DHW sensortype was not compatible for AUTO mode
177	DHW priority source setting was invalid
178	DHW priority method setting was invalid
	CH Operation Faults (continued)
179	CH S5 (J8 terminal 11) sensor was invalid
180	CH inlet temperature was invalid
181	CH S10 (J10 terminal 7) sensor was invalid
182	Lead Lag CH setpoint source was invalid
	Lead Lag Parameter errors
183	Lead Lag P-gain was invalid
184	Lead Lag I-gain was invalid
185	Lead Lag D-gain was invalid
186	Lead Lag OFF hysteresis was invalid
187	Lead Lag ON hysteresis was invalid
188	Lead Lag slave enable was invalid
189	Lead Lag hysteresis step time was invalid
190	No Lead lag Modbus port was assigned

CODE	DESCRIPTION
191	Lead Lag base load common setting was invalid
192	Lead Lag DHW demand switch setting was
193	Lead Lag Mix demand switch setting was invalid
194	Lead Lag modulation sensor setting was invalid
195	Lead Lag backup modulation sensor setting was invalid
196	Lead Lag slave mode setting was invalid
197	Lead Lag rate allocation setting was invalid
198	Lead selection setting was invalid
199	Lag selection setting was invalid
200	Lead Lag slave return setting was invalid
201	Lead Lag add stage method setting was invalid
202	STAT may not be a Lead Lag CH demand source when Remote Stat is enabled
203	Lead Lag base load rate setting was invalid
	Lead Lag Operation Faults
204	Lead Lag master was suspended due to fault
205	Lead Lag slave was suspended due to fault
206	Lead Lag header temperature was invalid
207	Lead Lag was suspended due to no enabled Program Module installed
208	Lead Lag slave session has timed out
209	Too many Lead Lag slaves were detected
210	Lead Lag slave was discovered
211	Incompatible Lead Lag slave was discovered
212	No base load rate was set for Lead Lag slave
213	Lead Lag slave unable to fire before demand to fire delay expired
214	Adding Lead Lag slave aborted due to add requirement change
215	No Lead Lag slaves available to service demand
216	No Lead Lag active service was set due to demand priority conflicts
217	No Lead Lag add stage method was specified
218	No Lead Lag drop stage method was specified
219	Using backup lead lag header sensor due to sensor failure
	Frost Protection Faults
220	Lead Lag frost protection rate was invalid
221	Lead Lag drop stage method setting was invalid
222	CH frost protection temperature was invalid
223	CH frost protection inlet temperature was invalid
224	DHW frost protection temperature was invalid
225-226	RESERVED
227	DHW priority override time was not derated due to invalid outdoor temperature
228	Warm weather shutdown was not checked due to invalid outdoor temperature
229	Lead Lag slave communication timeout
230	RESERVED

CODE	DESCRIPTION
231	Lead Lag CH setpoint was invalid
232	Lead Lag CH time of day setpoint was invalid
233	LL outdoor temperature was invalid
234	Lead Lag ODR time of day setpoint was invalid
235	Lead Lag ODR time of day setpoint exceeded normal setpoint
236	Lead Lag ODR max outdoor temperature was invalid
237	Lead Lag ODR min outdoor temperature was invalid
238	Lead Lag ODR low water temperature was invalid
239	Lead Lag ODR outdoor temperature range was too small (minimum 12°C/22°F)
240	Lead Lag ODR water temperature range was too too small (minimum 12°C/22°F)
241	Lead Lag DHW setpoint was invalid
242	Lead Lag Mix setpoint was invalid
243	Lead Lag CH demand switch was invalid
244	Lead Lag CH setpoint source was invalid
245	RESERVED
246	CH setpoint was invalid
247	CH time of day setpoint was invalid
248	CH outdoor temperature was invalid
249	CH ODR time of day setpoint was invalid
250	CH ODR time of day setpoint exceeds normal setpoint
251	CH max outdoor setpoint was invalid
252	CH min outdoor setpoint was invalid
253	CH min water setpoint was invalid
254	CH outdoor temperature range was too small
255	CH water temperature range was too small
256	Steam setpoint was invalid
257	Steam time of day setpoint was invalid
258	Steam minimum pressure was invalid
259	CH ODR min water temperature was invalid
260	RESERVED
261	DHW setpoint was invalid
262	DHW time of day setpoint was invalid
263	DHW storage setpoint was invalid
264	STAT may not be a DHW demand source when Remote Stat is enabled
265-266	RESERVED
267	STAT may not be a CH demand source when Remote Stat is enabled
268	CH 4mA water temperature setting was invalid
269	CH 20mA water temperature setting was invalid
270	Steam 4mA water temperature setting was invalid
271	Steam 20mA water temperature setting was invalid
272	Abnormal Recycle: Pressure sensor fault
273	Abnormal Recycle: Safety relay drive test failed

CODE	DESCRIPTION
274	Abnormal Recycle: Demand off during Pilot Flame Establishing Period
275	Abnormal Recycle: LCI off during Drive to Purge Rate
276	Abnormal Recycle: LCI off during Measured Purge Time
277	Abnormal Recycle: LCI off during Drive to Lightoff Rate
278	Abnormal Recycle: LCI off during Pre-Ignition test
279	Abnormal Recycle: LCI off during Pre-Ignition time
280	Abnormal Recycle: LCI off during Main Flame Establishing Period
281	Abnormal Recycle: LCI off during Ignition period
282	Abnormal Recycle: Demand off during Drive to Purge Rate
283	Abnormal Recycle: Demand off during Measured Purge Time
284	Abnormal Recycle: Demand off during Drive to Lightoff Rate
285	Abnormal Recycle: Demand off during Pre-Ignition test
286	Abnormal Recycle: Demand off during Pre-Ignition time
287	Abnormal Recycle: Flame was on during Safe Check
288	Abnormal Recycle: Flame was on during Drive to Purge Rate
289	Abnormal Recycle: Flame was on during Measured Purge Time
290	Abnormal Recycle: Flame was on during Drive to Lightoff Rate
291	Abnormal Recycle: Flame was not on at end of Ignition period
292	Abnormal Recycle: Flame was lost during Main Flame Establishing Period
293	Abnormal Recycle: Flame was lost early in Run
294	Abnormal Recycle: Flame was lost during Run
295	Abnormal Recycle: Leakage test failed
296	Abnormal Recycle: Interrupted air flow switch was off during Drive to Purge Rate
297	Abnormal Recycle: Interrupted air flow switch was off during Measured Purge Time
298	Abnormal Recycle: Interrupted air flow switch was off during Drive to Lightoff Rate
299	Abnormal Recycle: Interrupted air flow switch was off during Pre-Ignition test
300	Abnormal Recycle: Interrupted air flow switch was off during Pre-Ignition time
301	Abnormal Recycle: Interrupted air flow switch was off during Main Flame Establishing Period
302	Abnormal Recycle: Ignition failed due to interrupted air flow switch was off
303	Abnormal Recycle: ILK off during Drive to Purge Rate

CODE	DESCRIPTION
304	Abnormal Recycle: ILK off during Measured Purge Time
305	Abnormal Recycle: ILK off during Drive to Lightoff Rate
306	Abnormal Recycle: ILK off during Pre-Ignition test
307	Abnormal Recycle: ILK off during Pre-Ignition time
308	Abnormal Recycle: ILK off during Main Flame Establishing Period
309	Abnormal Recycle: ILK off during Ignition period
310	Run was terminated due to ILK was off
311	Run was terminated due to interrupted air flow switch was off
312	Stuck reset switch
313	Run was terminated due to fan failure
314	Abnormal Recycle: Fan failed during Drive to Purge Rate
315	Abnormal Recycle: Fan failed during Measured Purge Time
316	Abnormal Recycle: Fan failed during Drive to Lightoff Rate
317	Abnormal Recycle: Fan failed during Pre-Ignition test
318	Abnormal Recycle: Fan failed during Pre-Ignition time
319	Abnormal Recycle: Fan failed during Ignition period
320	Abnormal Recycle: Fan failed during Main Flame Establishing Period
321	Abnormal Recycle: Main Valve off after 10 seconds of RUN
322	Abnormal Recycle: Pilot Valve off after 10 seconds of RUN
323	Abnormal Recycle: Safety Relay off after 10 seconds of RUN
324	Abnormal Recycle: Hardware flame bias
325	Abnormal Recycle: Hardware static flame
326	Abnormal Recycle: Hardware flame current invalid
327	Abnormal Recycle: Hardware flame rod short
328	Abnormal Recycle: Hardware invalid power
329	Abnormal Recycle: Hardware invalid AC line
330	Abnormal Recycle: Hardware SLO flame ripple
330	Abnormal Recycle: Hardware SLO flame sample
332	Abnormal Recycle: Hardware SLO flame bias range
333	Abnormal Recycle: Hardware SLO flame bias heat
334	Abnormal Recycle: Hardware SLO spark stuck
335	Abnormal Recycle: Hardware SLO spark changed
336	Abnormal Recycle: Hardware SLO static flame
337	Abnormal Recycle: Hardware SLO rod shorted
338	Abnormal Recycle: Hardware SLO AD linearity
339	Abnormal Recycle: Hardware SLO bias not set
340	Abnormal Recycle: Hardware SLO bias shorted

CODE	DESCRIPTION
341	Abnormal Recycle: Hardware SLO electronics
342	Abnormal Recycle: Hardware processor clock
343	Abnormal Recycle: Hardware AC phase
344	Abnormal Recycle: Hardware A2D mismatch
345	Abnormal Recycle: Hardware VSNSR A2D
346	Abnormal Recycle: Hardware 28V A2D
347	Abnormal Recycle: Hardware HFS IAS shorted
348	Abnormal Recycle: Hardware PII INTLK shorted
349	Abnormal Recycle: Hardware HFS LCI shorted
350	Abnormal Recycle: Hardware HFS LFS shorted
351	Abnormal Recycle: Invalid zero crossing
352	Abnormal Recycle: fault stack sensor
353	Abnormal Recycle: stack limit
354	Abnormal Recycle: delta T limit
355	Abnormal Recycle: fault outlet sensor
356	Abnormal Recycle: outlet high limit
357	Abnormal Recycle: fault DHW sensor
358	Abnormal Recycle: DHW high limit
359	Abnormal Recycle: fault inlet sensor
360	Abnormal Recycle: Check Parameters Failed
	Internal Errors
361	Internal error: No factory parameters were detected in control
362	Internal error: PID iteration frequency was invalid
363	Internal error: Demand-Rate interval time was invalid
364	Internal error: Factory calibration parameter for modulation was invalid
365	Internal error: CH PID P-scaler was invalid
366	Internal error: CH PID I-scaler was invalid
367	Internal error: CH PID D-scaler was invalid
368	Internal error: DHW PID P-scaler was invalid
369	Internal error: DHW PID I-scaler was invalid
370	Internal error: DHW PID D-scaler was invalid
371	Internal error: Lead Lag master PID P-scaler was invalid
372	Internal error: Lead Lag master PID I-scaler was invalid
373	Internal error: Lead Lag master PID D-scaler was invalid
374	Abnormal Recycle: Hardware flame bias high
375	Abnormal Recycle: Hardware flame bias low
376	Abnormal Recycle: Hardware flame bias delta high
377	Abnormal Recycle: Hardware flame bias delta low
378	Abnormal Recycle: Hardware flame bias dynamic high
379	Abnormal Recycle: Hardware flame bias dynamic low
380	Abnormal Recycle: Fan Speed Not Proven
381	Abnormal Recycle: Fan Speed Range Low

CODE	DESCRIPTION
382	Abnormal Recycle: Fan Speed Range High
383-450	RESERVED
	Circulator Errors
451	Circulator control was invalid
452	Circulator P-gain was invalid
453	Circulator I-gain was invalid
454	Circulator temperature was invalid
455	Circulator outlet temperature was invalid
456	Circulator inlet temperature was invalid
457	Circulator outdoor temperature was invalid
458	Circulator sensor choice was invalid
459	Circulator PID setpoint was invalid
	Debug Faults
460	LCI lost in run
461	Abnormal Recycle: Demand lost in run from application
462	Abnormal Recycle: Demand lost in run due to high limit
463	Abnormal Recycle: Demand lost in run due to no flame
464	LCI lost in Combustion Pressure Establishing Period
465	LCI lost in Combustion Pressure Stabilization Period
466	RESERVED
	Internal Data Faults
467	Internal error: EEPROM write was attempted before EEPROM was initialized
468	Internal error: EEPROM cycle count address was invalid
469	Internal error: EEPROM days count address was invalid
470	Internal error: EEPROM hours count address was invalid
471	Internal error: Lockout record EEPROM index was invalid
472	Internal error: Request to write PM status was invalid
473	Internal error: PM parameter address was invalid
474	Internal error: PM safety parameter address was invalid
475	Internal error: Invalid record in lockout history was removed
476	Internal error: EEPROM write buffer was full
477	Internal error: Data too large was not written to EEPROM
478	Internal error: Safety key bit 0 was incorrect
479	Internal error: Safety key bit 1 was incorrect
480	Internal error: Safety key bit 2 was incorrect
481	Internal error: Safety key bit 3 was incorrect

CODE	DESCRIPTION
482	Internal error: Safety key bit 4 was incorrect
483	Internal error: Safety key bit 5 was incorrect
484	Internal error: Safety key bit 6 was incorrect
485	Internal error: Safety key bit 7 was incorrect
486	Internal error: Safety key bit 8 was incorrect
487	Internal error: Safety key bit 9 was incorrect
488	Internal error: Safety key bit 10 was incorrect
489	Internal error: Safety key bit 11 was incorrect
490	Internal error: Safety key bit 12 was incorrect
491	Internal error: Safety key bit 13 was incorrect
492	Internal error: Safety key bit 14 was incorrect
493	Internal error: Safety key bit 15 was incorrect
494	Internal error: Safety relay timeout
495	Internal error: Safety relay commanded off
496	Internal error: Unknown safety error occurred
497	Internal error: Safety timer was corrupt
498	Internal error: Safety timer was expired
499	Internal error: Safety timings
500	Internal error: Safety shutdown
501	RESERVED
	MIX Errors
502	Mix setpoint was invalid
503	Mix time of day setpoint was invalid
504	Mix outdoor temperature was invalid
505	Mix ODR time of day setpoint was invalid
506	Mix ODR time of day setpoint exceeds normal setpoint
507	Mix ODR max outdoor temperature was invalid
508	Mix ODR min outdoor temperature was invalid
509	Mix ODR low water temperature was invalid
510	Mix ODR outdoor temperature range was invalid
511	Mix ODR water temperature range was invalid
512	Mix demand switch was invalid
513	Mix ON hysteresis was invalid
514	Mix OFF hysteresis was invalid
515	Mix ODR min water temperature was invalid
516	Mix hysteresis step time was invalid
517	Mix P-gain was invalid
518	Mix I-gain was invalid
519	Mix D-gain was invalid
520	Mix control was suspended due to fault
521	Mix S10 (J10-7) temperature was invalid
522	Mix outlet temperature was invalid
523	Mix inlet temperature was invalid
524	Mix S5 (J8-11) temperature was invalid
525	Mix modulation sensor type was invalid
526	Mix ODR min water temperature setpoint was invalid

CODE	DESCRIPTION
527	Mix circulator sensor was invalid
528	Mix flow control was invalid
529	Mix temperature was invalid
530	Mix sensor was invalid
531	Mix PID setpoint was invalid
532	STAT may not be a Mix demand source when Remote Stat is enabled
533-539	RESERVED
540	Delta T inlet/outlet enable was invalid
541	Delta T exchanger/outlet enable was invalid
542	Delta T inlet/exchanger enable was invalid
543	Delta T inlet/outlet degrees was out of range
544	Delta T exchanger/outlet degrees was out of range
545	Delta T inlet/exchanger degrees was out of range
546	Delta T response was invalid
547	Delta T inversion limit response was invalid
548	Delta T rate limit enable was invalid
549	Delta T exchanger/outlet wasn't allowed due to stack limit setting
550	Delta T inlet/outlet limit was exceeded
551	Delta T exchanger/outlet limit was exceeded
552	Delta T inlet/exchanger limit was exceeded
553	Inlet/outlet inversion occurred
554	Exchanger/outlet inversion occurred
555	Inlet/exchanger inversion occurred
556	Delta T exchanger/outlet wasn't allowed due to stack connector setting
557	Delta T inlet/exchanger wasn't allowed due to stack limit setting
558	Delta T inlet/exchanger wasn't allowed due to stack connector setting
559	Delta T delay was not configured for recycle response
	T Rise Errors
560	Outlet T-rise enable was invalid
561	Heat exchanger T-rise enable was invalid
562	T-rise degrees was out of range
563	T-rise response was invalid
564	Outlet T-rise limit was exceeded
565	Heat exchanger T-rise limit was exceeded
566	Heat exchanger T-rise wasn't allowed due to stack limit setting
567	Heat exchanger T-rise wasn't allowed due to stack connector setting
568	Outlet T-rise wasn't allowed due to outlet connector setting
569	T-rise delay was not configured for recycle response
	Heat Exchanger High Limit Errors
570	Heat exchanger high limit setpoint was out of range

CODE	DESCRIPTION
571	Heat exchanger high limit response was invalid
572	Heat exchanger high limit was exceeded
573	Heat exchanger high limit wasn't allowed due to stack limit setting
574	Heat exchanger high limit wasn't allowed due to stack connector setting
575	Heat exchanger high limit delay was not configured for recycle response
	Pump Errors
576	CH pump output was invalid
577	DHW pump output was invalid
578	Boiler/water heater pump output was invalid
579	Auxiliary pump output was invalid
580	System pump output was invalid
581	Mix pump output was invalid
582-589	RESERVED
	DHW Plate Heat Exchanger Errors
590	DHW plate preheat setpoint was invalid
591	DHW plate preheat ON hysteresis was invalid
592	DHW plate preheat OFF hysteresis was invalid
593	Tap detect degrees was out of range
594	Tap detect ON hysteresis was invalid
595	Inlet - DHW tap stop degrees was out of range
596	Outlet - Inlet tap stop degrees was out of range
597	DHW tap detect on threshold was invalid
598	DHW plate preheat detect on threshold was invalid
599	DHW plate preheat detect off threshold was invalid

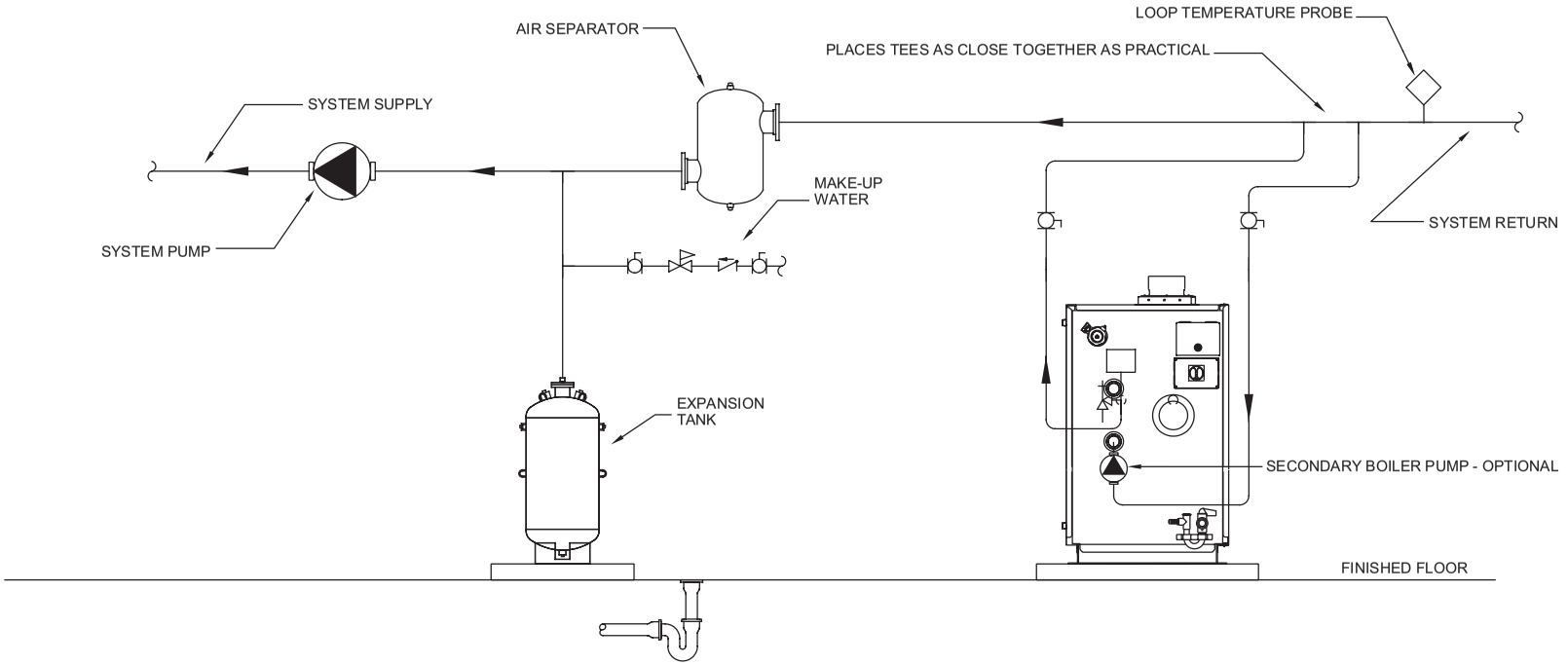
XB BOILERS (1000-3400) - ONE BOILER PRIMARY / SECONDARY HYDRONIC PIPING SYSTEM

WARNING: THIS DRAWING SHOWS SUGGESTED PIPING CONFIGURATION AND OTHER DEVICES; CHECK WITH LOCAL CODES AND ORDINANCES FOR ADDITIONAL REQUIREMENTS.

MODEL	INLET DIA.	OUTLET DIA.
XB-1000	2”	2”
XB-1300	2”	2”
XB-1700	2.5”	2.5”
XB-2000	3”	3”
XB-1600	3”	3”
XB-3400	4”	4”

LEGEND

- TEMPERATURE & PRESSURE RELIEF VALVE
- PRESSURE RELIEF VALVE
- CIRCULATING PUMP
- TANK TEMPERATURE CONTROL
- DRAIN
- FULL PORT BALL VALVE
- CHECK VALVE
- TEMPERATURE GAGE
- WATER FLOW SWITCH



NOTES:

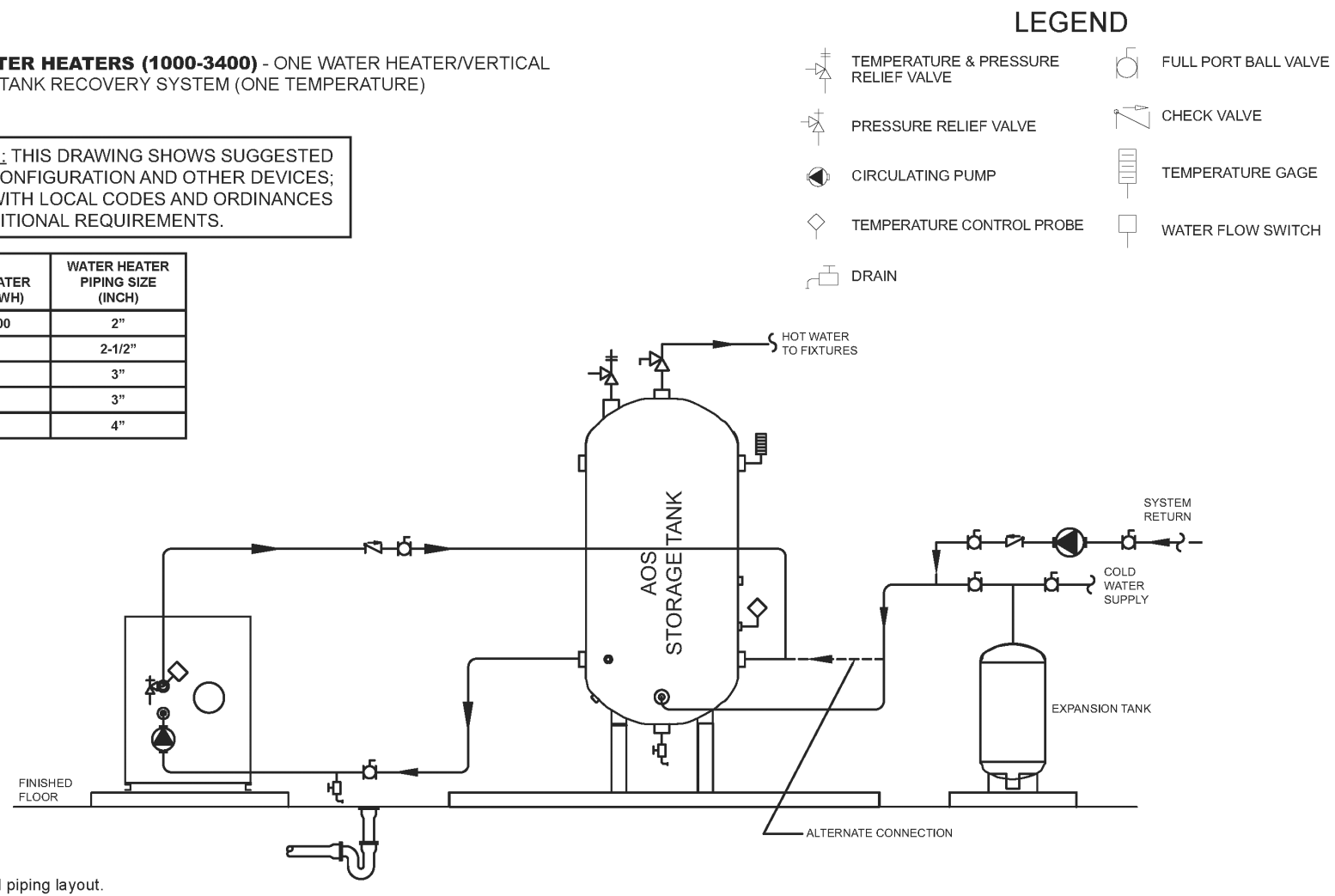
1. Preferred piping diagram.
2. The temperature and pressure relief valve setting shall not exceed pressure rating of any component in the system.
3. Service valves are shown for servicing unit. However, local codes shall govern their usage.
4. The boiler is shown with the optional factory installed and sized secondary boiler pump that is available on all XB models.

FIGURE 55. PRIMARY/SECONDARY PIPING SYSTEM

XWH WATER HEATERS (1000-3400) - ONE WATER HEATER/VERTICAL STORAGE TANK RECOVERY SYSTEM (ONE TEMPERATURE)

CAUTION: THIS DRAWING SHOWS SUGGESTED PIPING CONFIGURATION AND OTHER DEVICES; CHECK WITH LOCAL CODES AND ORDINANCES FOR ADDITIONAL REQUIREMENTS.

XP WATER HEATER MODEL (XWH)	WATER HEATER PIPING SIZE (INCH)
1000-1300	2”
1700	2-1/2”
2000	3”
2600	3”
3400	4”



NOTES:

1. Preferred piping layout.
2. The temperature and pressure relief valve setting shall not exceed pressure rating of any component in the system.
3. Service valves are shown for servicing water heater. However, local codes shall govern their usage.
4. A. O. Smith piping method is based on the 50 equivalent feet of piping. Water heater placement shall be as close as practical to the storage tank. Applications in excess of these recommendations shall require a licensed engineer for design assistance.

FIGURE 56. HOT WATER SUPPLY WATER HEATER WITH VERTICAL TANK

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